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LEGAL MEDICINE

BY

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VOLUME II.

EXPECTATION OF LIFE

PRESUMPTION OF DEATH AND SURVIVORSHIP

HEAT AND COLD

BURNS AND SCALDS

LIGHTNING

EXPLOSIVES AND COMBUSTIBLES

STARVATION; ITS TREATMENT

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CONTENTS.

CHAPTER I.

Expectation of Life.

Presumption of Death and of Survivorship.

CHAPTER II.

HEAT AND COLD.

(CONSIDERED MEDICO-LEGALLY.)

(A.) EFFECTS OF EXTREME COLD.

CHAPTER III.

BURNS AND SCALDS.

(CONSIDERED MEDICO-LEGALLY.)

CHAPTER IV.

Lightning.

CHAPTER V.

Combustibles and Explosives.

A.—Solid Combustibles, Etc.

CHAPTER VI.

Starvation.

LEGAL MEDICINE.

CHAPTER I.

EXPECTATION OF LIFE.—PRESUMPTION OF DEATH AND OF SURVIVORSHIP.

Expectation of Life.—Life Insurance.—A Medical Examination.—Unusual Risks.—Insurance against Accident.—*Presumption of Death.*—*Presumption of Survivorship.*

(Illustrative Cases, page 35.)

I.

The Expectation of Life: (*Insurance.*)

Life Insurance is a contract. *On the one part the insured* pays the insurers a certain amount, either in a lump sum or in yearly or quarterly instalments (called *the premium*), and *on the other part the insurers* agree to pay a certain sum of money to the executors or assigns of the insured at death, or to him at a certain age agreed upon, or if he die before this time to his executors.

Sometimes insurances are effected for a limited number of years, payment of the sum assured to be made only if the person die during the period of the insurance. Various other special contracts may also be entered into.

The writing by which all these contracts are made is termed *a policy.*

In the remarks we have to make we shall use the word *applicant*, to signify the person who makes an application to insure a life—the *insured*, to signify the person on whom the policy is granted—and the *insurers*, the office that grants the policy.

Table of the Expectation of Life.

Age.	Healthy Lives, Male.	Healthy Lives, Female.	Healthy Lives, Male and Female.	Diseased Lives, Male and Female.	Age.	Healthy Lives, Male.	Healthy Lives, Female.	Healthy Lives, Male and Female.	Diseased Lives, Male and Female.
	Years of Life.	Years of Life.	Years of Life.	Years of Life.		Years of Life.	Years of Life.	Years of Life.	Years of Life.
0	58.43	55.53	57.64	55.56	50	20.30	21.60	20.51	18.29
1	57.43	54.53	56.64	54.56	51	19.63	20.94	19.84	17.73
2	56.43	53.53	55.64	53.56	52	18.97	20.18	19.17	17.13
3	56.31	52.53	55.09	52.56	53	18.29	19.60	18.50	16.52
4	55.31	53.04	54.83	51.56	54	17.60	18.86	17.81	15.93
5	54.31	52.04	53.83	50.56	55	16.93	18.17	17.14	15.45
6	53.76	51.04	53.08	49.56	56	16.32	17.53	16.53	14.84
7	53.13	50.90	52.67	48.56	57	15.69	16.88	15.90	14.20
8	52.13	49.90	51.67	47.56	58	15.07	16.16	15.26	13.74
9	51.13	49.18	50.80	46.56	59	14.44	15.56	15.64	13.23
10	50.29	48.18	49.89	45.56	60	13.80	14.85	13.99	12.62
11	49.69	47.78	49.38	44.56	61	13.23	14.21	13.42	12.19
12	48.69	46.78	48.38	43.56	62	12.66	13.50	12.83	11.60
13	47.88	45.78	47.50	42.56	63	12.09	12.92	12.26	11.09
14	47.05	44.78	46.60	41.56	64	11.54	12.38	11.72	10.64
15	46.24	44.27	45.90	40.56	65	11.01	11.78	11.17	10.26
16	45.34	43.82	45.14	39.56	66	10.49	11.24	10.65	9.85
17	44.34	43.11	44.23	39.09	67	9.98	10.63	10.12	9.38
18	43.53	42.20	43.39	38.09	68	9.46	10.10	9.61	8.99
19	42.79	41.42	42.64	37.09	69	8.99	9.60	9.13	8.56
20	42.09	40.87	41.98	36.80	70	8.54	9.12	8.68	8.16
21	41.33	40.17	41.23	36.16	71	8.02	8.61	8.16	7.67
22	40.62	39.40	40.51	35.73	72	7.52	8.09	7.65	7.18
23	39.87	38.61	39.84	35.15	73	7.12	7.58	7.24	6.77
24	39.18	37.95	39.15	34.84	74	6.69	7.27	6.83	6.32
25	38.44	37.40	38.44	34.01	75	6.42	6.99	6.56	6.10
26	37.64	36.80	37.65	33.47	76	6.03	6.57	6.17	5.90
27	36.90	36.21	36.93	32.87	77	5.69	6.29	5.85	5.69
28	36.14	35.69	36.18	32.36	78	5.33	5.92	5.48	5.38
29	35.42	35.07	35.47	31.64	79	5.00	5.86	5.22	5.21
30	34.68	34.55	34.75	31.03	80	4.71	5.56	4.93	4.98
31	33.96	33.90	34.04	30.46	81	4.40	5.17	4.61	4.60
32	33 21	33.27	33.30	29.81	82	4.14	4.90	4.36	4.52
33	32.48	32.75	32.59	29.13	83	3.90	4.35	4.04	4.17
34	31.75	32.04	31.86	28.43	84	3.79	3.92	3.84	3.52
35	31.03	31.43	31.15	27.76	85	3.51	3.71	3.58	3.01
36	30.28	30.80	30.41	27.11	86	3.34	3.62	3.44	2.87
37	29.55	30.21	29.69	26.51	87	3.13	3.51	3.26	2.69
38	28.83	29.55	28.97	25.75	88	2.87	3.40	3.05	2.99
39	28.12	28.88	28.27	25.13	89	2.81	3.14	2.94	2.78
40	27.42	28.24	27.57	24.49	90	2.35	3.33	2.68	4.05
41	26.69	27.59	26.85	23.82	91	1.91	3.88	2.46	3.05
42	25.96	26.97	26.14	23.15	92	1.55	3.72	2.25	2.90
43	25.24	26.30	25.42	22.51	93	1.40	3.71	2.34	3.50
44	24.50	25.68	24.69	21.80	94	2.21	3.25	2.90	2.50
45	23.79	24.96	23.98	21.11	95	1.21	2.25	1.90	1.50
46	23.08	24.26	23.27	20.95	96	.50	1.25	1.06	.50
47	22.37	23.68	22.57	20.26-	97	——	1.00	1.00	——
48	21.68	23.02	21.89	19.57	98	——	.50	.50	——
49	20.98	22.34	21.20	18.92					

Nothing is more uncertain than the duration of a single life, and but few things less uncertain than the average duration of a number of lives. Given therefore (1) a healthy life, and (2) the absence of any unusual risk, the age of the applicant is practically the only matter for the consideration of an insurance company in granting a policy.

First, then, as to the age of the applicant. Certain well-known tables of the expectation of life at different ages, constitute the basis on which the charge to be made is calculated. Of such tables that on page 2, collected by the Institute of Actuaries, has been selected.

The expectation of life, by which is implied the number of years that, on an average, a healthy person will live at that age, is capable of reduction to a mathematical formula. Thus, excluding all persons under 25 and over 75 years of age from our calculations, the formula of Willich, in which x represents the expectation of life, and a the age of the person, nearly represents the facts:—

$$x = \tfrac{2}{3}\,(80 - a).$$

The next question for consideration is—Is the life of the applicant a healthy one? To test this, he is required:—

(1.) To give the names of the different medical men that have attended him from time to time.

(2.) To answer a series of questions, of which the declaration on page 4 may serve as an illustration.

(3.) The person whose life is to be insured, is required to submit himself for examination by the medical adviser of the office.

The Medical Examination.

In conducting a medical examination the physician should first of all read over the applicant's statement respecting his family history and previous health. Strict inquiry should then be made respecting habits of life, the amount of stimulants commonly taken, etc. If there be heat of skin, the temperature should be observed before he is undressed.

DECLARATION OF THE PERSON TO BE ASSURED.

ARRANGED BY DR. DOBELL.

QUESTIONS TO BE REPLIED TO BY THE ASSURER WHOSE NAME IS HEREUNTO AFFIXED BEFORE EXAMINATION. The Directors wish to impress upon the Assurer the necessity of giving *full* and *correct* answers to the following questions:—

1.—Age *next* birthday? .. ..
Married or single? .. ..

2.—What is your occupation? Is it active or sedentary? .. ..
How do you bear unusual fatigue? .. ..

3.—If now and generally in good health? .. ..
(*a.*) State your Height..........feet......... inches. Weight..........stones......... lbs.
(*b.*) Are you increasing or decreasing in weight? .. ..

Particular attention is directed to this point.

4.—Are your habits of life sober and temperate? .. .. ..
Have they *always* been so? .. ..

5.—Have you had the small-pox or been vaccinated? (state which)

6.—Have you ever been bled or cupped, or undergone any Surgical Operation? If in the affirmative state particulars .. ..

IF THE ANSWER IS AFFIRMATIVE, GIVE PARTICULARS.

7.—Have you ever suffered from:—
Varicose Veins? .. ..
Rupture? if so, is a truss constantly worn? .. .. ..
Delirium tremens, apoplexy, fits of any kind, paralysis? ..
Any head affection? .. ..
Spitting or other discharges of blood? (describe fully) ..
Cough? if so, its character and duration? .. .. ..
Any affection of the chest, or throat? .. ..
Cancer, scrofula, jaundice, or dropsy?.. . .. ..
Gout, when, and in what part? .. ..
Rheumatic fever, when, and its duration, and was your Heart affected by it? .. ..
Rheumatism? .. ..
Any affection of the stomach or bowels? .. .. ..
Piles or fistula, which? .. ..
Any affection of the kidneys or bladder? (state particulars)
Have you had any illness not already stated? .. ..

N. B.—Mnch trouble and after-correspondenoe will be spared by distinct information as to the causes of death.
When there is any doubt about the cause of death (or when it is said to have been connected with child-birth), state DEFINITELY whether the person was, or was not Consumptive.

8.—Family History.
Father alive, aged....................*Health*..
Mother alive, aged....................*Health*..
Father died, aged....................*Cause of death*..................................
Mother died, aged....................*Cause of death*..................................
...................*Brothers alive, ages and health*.....................................
...................*Sisters alive, ages and health*......................................
...................*Brothers died, ages and causes of death*.............................
...................*Sisters died, ages and causes of death*..............................

9.—Has any member of your family not mentioned above, suffered from Consumption or insanity? if so, give particulars. (This refers especially to Uncles, Aunts, and first Cousins.)

10.—Have you ever resided abroad, where, and for what period? If so, was your health affected thereby? .. .. ..

11.—Do you know, have you been informed, or do you suspect that disease or disorder of any kind exists in your constitution?

12.—Are you aware of any circumstance not already stated, connected with your family, or your own constitution, health, or habits, tending to render an assurance on your life more than usually hazardous? .. ..

13.—IF A WOMAN—
(*a.*) What is the condition of the uterine functions at present? and in general? .. ..
(*b.*) If married, how long? .. ..
(*c.*) Have you ever had any children or miscarriages, and have your confinements proved favorable or not? .. ..
(*d.*) State whether pregnant or not? .. ..

I hereby declare that the answers to the above qnestions are to the best of my knowledge and belief in all respects true.

As Witness my hand this................*day of*................, 18

Signature of the Assurer......................................

Signed in the presence of the Medical Examiner whose name is hereunto affixed. } ....

This Signature must be witnessed by the Medical Examiner.

Investigate, in turn, the following systems:—

(1.) *The Nervous and Muscular Systems.*—(Note that tremor of the muscles is generally of nervous origin, and that their tonicity is greatly dependent on the nervous system.)—Under this heading, paralyses, the increase or loss of sensibility (hyper- and an-æsthesia), affections of the senses (sight, smell, hearing, etc.), are to be included. Particular inquiries should be made as to family neuroses, such as chorea, epilepsy, insanity, etc.

(2.) *The Respiratory System.*—Since about one in every six of the deaths in this country is caused by a disease of the lungs or air-passages, it is clear that too great attention cannot be given to the condition of the respiratory system. Healthy respiration should be quiet and easy, in the ratio of one to four or five of the pulse, and not exceeding twenty per minute in adults. The chest should expand freely in all directions, the muscles of the neck and arms (auxiliary muscles) taking no very visible part in the act of breathing. The respiratory murmur should be neither harsh nor noisy. Drawing a full breath, and holding it for a few seconds, should cause no distress. An adult should be able to count aloud, rather slowly, from twenty to thirty without drawing fresh breath. If the blood be well aërated, the lips, ears, and tips of the fingers should present no appearance of a purple or livid tint.

(3.) *The Circulatory System.*—Since diseases of the heart have, practically, only two terminations—the one, *Sudden death* (a common ending to fatty and brown degeneration, dilatation and atrophy, aortic regurgitation, disease of the coronary arteries, etc.), and the other, *Dropsy* (a common ending to almost every form of disease of the heart and its appendages), Insurance Offices attach great importance to the condition of this organ. Experience proves, however, that many cases of valvular disease of the heart may attain a good age if the surroundings are favorable, and the patients themselves careful. Dr. Begbie ("*Edin. Med. Journ.*," Dec., 1874), for example, found, from the experience of the Scottish Widows' Fund Life Assurance Society (1815 to 1873), that one-third of the cases of heart disease actually lived longer than the average expectation of life, the remaining two-thirds, however, bearing out the general idea of the greater risk. Thus heart diseases constituted 14.202 per cent. of all the deaths (800 in 5,633) during the period named.

In forming an estimate of the condition of the heart, the following are the chief data:—The pulse should be regular and not jerking;—it should neither be too compressible nor too hard. Its beats should be about four or five to each respiration; and in the case of adults, sit-

ting, should not be below 70, or above 85 per minute. (Exceptional cases of very slow and of very rapid pulse, with good health, are met with, but they are rare.) Change of posture should not make a greater difference than about ten beats per minute. The beats of the heart should be clear and unattended by any murmur, or by any blowing or rubbing sounds. The first sound should be the louder, longer, and lower-pitched. The apex-beat of the heart should be ¾ inch within, and about 1½ inch below, the left nipple (*i.e.*, in the fifth costal interspace), and the impulse, whilst plainly perceptible, should neither be jerking nor too widely diffused.

(4.) *The Digestive System.*—Although people with feeble digestions often live a long time, yet it may be laid down as a practical fact that those who have good digestions will, *cæteris paribus*, live the longest, bear most fatigue, and stand the risks of heat, cold, and exposure to contagion best. It is in this direction, too, that habits of intemperance (chronic alcoholism) make themselves most felt. The principal points for investigation under this heading are—the state of the tongue and mucous membrane of the mouth; the appetite; the regularity of the bowels; the presence or absence of symptoms of dyspepsia; the size of the liver; the color of the skin and conjunctivæ; the presence or absence of abdominal tumors, etc.

(5.) *The Genito-Urinary System.*—A sample of the urine should in all cases be examined. The following are bad indications, and suggest special inquiries:—Puffiness of the eyelids, backs of the hands, and dorsum of the feet; œdema of the scrotum or vulva; nocturnal micturition; morning sickness (apart from pregnancy), a symptom common in dram-drinkers; lumbar pains; dysuria; the presence in the urine of albumen, sugar, pus, and blood; also, if persistently or in any quantity, of phosphates, uric acid, urates, and oxalates; also of bile-pigment, cancer-cells, epithelial and other tube-casts from the kidneys, and a very high or very low specific gravity, with any marked increase or decrease in the quantity of urine. It is well known that albuminuria and granular or contracted kindneys, are unfavorable prognostics for the success of operations, or for recovery from accidents and diseases.

[*Note.*—The sp. gr. of healthy urine varies from 1015 to 1025. The quantity normally secreted is from 40 to 60 ozs. daily, which should contain from 400 to 500 grains of urea. The color should be pale amber, the reaction faintly acid, and the odor not disagreeable. It should be clear when passed, and only deposit a slight cloud of mucus after standing from ten to twelve hours.]

CONFIDENTIAL REPORT BY THE MEDICAL EXAMINER, WHOSE NAME IS HEREUNTO AFFIXED.

ARRANGED BY DR. DOBELL.

On the Life of.... ....*of*..

1.—Was the declaration already given signed in your presence? ..
Is the Assurer known to you? and what opportunities have you had of becoming acquainted with his health, habits, and constitution? .. ..
Describe the present appearance. .. ..
Is the aspect healthy? .. ..

2.—What is the *actual* rate of pulse (standing)? . .. ..
Is the pulse normal in rhythm, volume, and force, etc.? ..
(*If the answer is in the negative, give particulars.*) ..
Are the pulsations and sounds of the heart quite normal? ..
If not, state defects. .. ..

If the applicant has ever suffered from Rheumatism, or Rheumatic Fever, please to direct especial attention to the heart.

3.—Are the proportions and development of the chest normal? ..
Is the general character of respiration normal? .. ..
Do the subclavian regions expand normally in respiration? ..
Is the respiratory murmur above and below the clavicles normal? .. ..
Can you detect by percussion or auscultation at any part of the chest, any abnormal sign not mentioned above? ..
What do you consider to be the condition of the lungs? ..
(*If there is anything abnormal, give particulars.*) .. ..

Attention is particularly requested to these questions, as Phthisis is one of the principal causes from which Insurance Offices suffer loss.

4.—What is the condition of the tongue? .. ..

5.—Have you any reason to suspect disease of the urinary or generative organs? .. ..
If you suspect disease of the kidneys, say is the urine coagulated by heat and nitric acid. .. ..

6.—Are there any traces of (*a*) paralysis, (*b*) syphilis, (*c*) jaundice, (*d*) gout, (*e*) rheumatism, (*f*) scrofula, (*g*) dropsy, and is there any reason to apprehend (*h*) an apoplectic seizure? .. ..

7.—If there is rupture, what is its nature and duration? .. ..
Is it constantly and efficiently supported by a truss? .. ..

8.—Have you reason from any source whatever to suspect the proposer *is now* or *has been* of irregular or *intemperate* habits, *or addicted to any habits or pursuits likely to shorten life?* ..

Attention is particularly requested to this point.

9.—Is any circumstance known or suspected by you not already stated, that might render the life more than usually hazardous? .. ..

CONFIDENTIAL OPINION.

I hereby certify that the answers given by me above are according to the best of my knowledge and belief, and, after a careful consideration of the personal condition and of the personal and family history, I am of opinion that the life should be placed in the :—

1st CLASS.—AVERAGE LIVES. Such as have either no unfavorable circumstances of health or family history, or in which the unfavorable circumstances are so slight as to form no impediment to Assurance at the usual rate... .. .. ..

2d CLASS LIVES.—Such as require an *addition* to the premium, to cover increased risk. State how many years should be added to the present age of Assurer to cover the risk.

3d CLASS LIVES.—Such as should be declined.

Signed.. ......

As regards the generative organs, sexual incapacity in males is an early symptom of diabetes and of many neuroses. It must be remembered, too, as regards females, that the uterus and ovaries are favorite seats of cancer and of cystic disease respectively. In the male, stricture of the urethra should be regarded as an element of danger.

The medical adviser having completed his Examination, is required to fill up for the guidance of the Board in assuring the life some such form as that on page 7.

Unusual Risks.

The age being proved, and the life judged a good one, the third and last question is the matter of risk. Speaking generally, the following lives are considered more than usually hazardous :—

(1.) *Those addicted to the use of alcohol, opium, etc., or whose occupations expose them to risks of poisoning.*

Amongst poisons, *Alcohol*, undoubtedly, in questions of insurance, holds the first place. Many Insurance Offices decline altogether the lives of publicans, hotel-keepers, and all employed in the manufacture, sale, and distribution of alcoholic beverages. Policemen, soldiers, sailors, butchers, watermen, etc., are liable to special temptations to drink from the nature of their callings.

The question whether the habitual use of opium has a tendency to shorten life, has also been raised. Granting that many opium-eaters achieve longevity, it cannot be doubted that the habitual use of any such drug must tend to injure health. (*Case* 37.) It should, however, be noted that opium has anti-periodic qualities, and that therefore in malarious districts it might tend to prolong life. The *law of tolerance*, moreover, must not be forgotten. If, however, opium be dangerous, the far too common use of chloral hydrate, of chloroform, and of ether, must be regarded as fraught with even greater danger—for in such cases the danger is of sudden death, which seldom happens to the habitual opium-eater as a direct consequence of his indulgence.

Again, it must be evident that those engaged in chemical manufactures, or in works where lead, arsenic, copper, mercury, phosphorus, and the mineral acids are employed, are exposed to special dangers.

(2.) *Those exposed to the action of sewer-gas, or to emanations from decomposing animal and vegetable matters*, e.g., *scavengers, the makers of blood-manure, etc.*

(3.) *Those exposed to accidents from gunpowder or other explosives, or to the falling in of rocks, etc.*, e.g., *miners, quarrymen, excavators, bricklayers, builders, plasterers, etc.*

(4.) *Those whose work is very dusty, such as millers, furriers, etc., also those employed in grinding cutlery; also millstone dressers, stone-masons, etc.*

(5.) *Those whose habits are sedentary, or who work in badly ventilated, close, and dark rooms, or whose hours of work are long*, e.g., *factory hands, clerks, drapers, millinery assistants, shoemakers, tailors, printers, bakers, the employés in theatres, music halls, etc.*

(6.) *Those whose occupations specially expose them to accidents or to mechanical violence or to injuries purposely inflicted*, e.g., *soldiers, sailors, policemen, firemen, grooms, and all who have to do with horses.* (These classes also are, unfortunately, much given, as a rule, to alcoholic liquors.)

(7.) *Lastly, in the case of those in the army and navy, an additional premium is charged on account of increased risk when actual service commences.* (A policy is void if a person not in service, and insured at ordinary risks, afterward enters the army or navy, and meets with his death on duty.)

The Influence of Climate on the duration of life must not be overlooked. In general it may be said that Europe, North America (including the Northern parts of the United States), the North of Asia, Southern Australia, New Zealand, the Cape Colony, the south of South America, and most islands are fairly healthy. To this general statement we must except low-lying districts, especially those on the seaboard and the estuaries of large rivers—certain cities and towns—marshy and undrained lands where ague predominates—and special localities, such as certain districts of the Alps renowned for goitre and cretinism, etc., etc. Again, what are generally known as "the tropics" (in other words, the district between 23° 28′ N., and the same distance S. of the equator), are, with few exceptions, more unhealthy than temperate climes, from the prevalence of sunstroke, plague, yellow fever, cholera, dysentery, small-pox, leprosy, and other diseases. Indeed this remark may be extended beyond the true tropics, for nearly the whole district between 45° of North latitude and 25° of South latitude must be considered risky. Here again certain exceptions must be made, such as the hill country of Hindostan, and certain parts of Persia and Africa.

The Influence of Pregnancy and Childbearing on life may be important in the insurance of females. Very few married women, it is true, die whilst actually pregnant, but it must not be assumed that pregnancy is a shield for any longer period than that of actual gestation. A considerable number of women die during their confinement. Again, the observations of obstetric authorities [1] show indisputably how much greater is the risk run by primiparæ than by multiparous females. Thus of 10,382 women confined for the first time, 168, or 1 in every 62, died; whilst of 26,394 multiparæ, 213, or 1 in every 124, died. Ignorance and carelessness are, we fear, to blame for much of this mortality, the great bulk of which ought to be prevented.

The last question that may arise is, Should the life examined be not healthy, how many additional years' premium will, in the judgment of the medical examiner, cover the risk?

On this point much must be left to the individual judgment. Dr. Sieveking's remarks are extremely pertinent. He says, "At present the suggestions offered by gentlemen of limited experience often show that they by no means appreciate the real question at issue, inasmuch as they state circumstances that materially affect the applicant's liability, and suggest additions to the tabular rate quite incommensurate with the manifestly increased risk to the office." The question to be considered is, How much is defect in the family history or disease of an individual likely to diminish his longevity, as compared with a person without such flaw in his antecedents?

Insurance against Accident.—In insurance against accident, the agreement stipulates that the insured shall receive a certain sum or sums, if he meet with an accident disabling him entirely or in part (the amount to be paid being dependent on the degree of the disablement), and that a fixed sum shall also be paid his executors if the accident prove fatal. At the present time, insurance against accident has assumed considerable importance. (*Cases* 51 to 57.)

The first question that arises is, *What do we mean by accident* in its relationship to personal insurance? An accident may be defined as an event occurring to an individual without his expectation, and without the possibility of his preventing it at the moment of its occurrence.

[1] "*Medical Examinations for Life Insurance*," by J. A. Allen, M.D. (New York, 1872), p. 175.

In *Case* 51 it was decided that death from sunstroke was not death from an accident. In this case Cockburn C.-J. made the following remarks:—"We think we may safely assume that by the term 'accident' as so used, some violence, casualty, or *vis major* is necessarily involved. We cannot think disease produced by the action of a known natural cause can be considered as accidental. Thus disease or death engendered by exposure to heat, cold, damp, the vicissitudes of climate, or atmospheric influences cannot, we think, properly be said to be accidental, at all events unless the exposure is itself brought about by circumstances which may give it the character of an accident."

It sometimes happens that a person insured against death by accident, receives an injury whilst suffering from some disease. Had he been well at the time, the accident might have caused temporary inconvenience only, but on account of his state of health it results in death. Provided the injury would under any circumstances, whatever the state of health, have caused death, it is certain that the mere fact that the person injured had at the time some disease which only accelerated the fatal effects of the accident, does not interfere with his executors' claim to the money. Further, if the insured whilst suffering from disease is accidentally injured, such accident occurring by reason of his diseased condition, and supposing further that the accident results in death, his executors will nevertheless be entitled to recover, except where the policy provides against such a contingency, *e.g.*, death resulting from injuries received whilst drunk. (*Case* 53.) The real distinction, however, which makes such a case an exception to the general rule is not so much the medical question involved—viz., the relation of the accident to the state of health of the insured—as the legal one, viz., whether the insured by losing control over himself, and in this condition incurring an injury, has not *ipso facto* deprived the injury of its accidental character.

In *Case* 54 the question was raised whether the accident resulted from circumstances over which the insured had no control—viz., a push in a crowd—or was the natural effect of intoxication. The verdict was against the Company.

With regard to policies of insurance against death from accident, there are two further points to be noticed:—

(1.) *First*, The medical jurist may be called on to pronounce from which of two causes a person died. For instance, in *Case* 56, the deceased insured his life against death by accident. Whilst fording a shallow brook he was seized with an epileptic fit, fell into the water,

and was drowned whilst suffering from the fit. The first question to be determined was—Did the death arise from drowning? This being fully established by medical evidence, it was then held that the fact that the fit caused the accident was no defence, although the policy contained a clause providing that the insurance should not extend "to any injury caused by, or arising from, natural disease, or weakness or exhaustion consequent upon disease."

(2.) *Secondly*, The medical jurist may be consulted as to the degree of the relationship between the accident and the death. Thus in *Case* 57, the assured accidentally cut his foot against the broken side of an earthenware pan on Saturday, April 24th. On the Thursday following erysipelas supervened, of which he died on Saturday, May 1st. The medical evidence proved that the erysipelas was caused by the wound. The policy contained a proviso that it was not to insure "against death arising from rheumatism, gout, hernia, *erysipelas*, or any other disease or secondary cause arising within the system of the insured before, or at the time of, or following, such accidental injury, whether causing such death directly or jointly with such accidental injury." It was held that the insurers were protected by the above condition, and were not liable. It would, however, be absurd to suppose, remembering how often erysipelas follows an injury, that a company can shield itself from its responsibilities under the plea that the death was the result of erysipelas, if that erysipelas was the result of an accident.

In all accident insurance cases, where disease and accident seem closely connected, the real questions for the consideration both of the Court and of the medical jurist, must always be somewhat as follows:—

1. The state of the person's health before the accident.

2. The relationship, in point of time, between the accident and the setting in of the disease.

3. The connection between the special disease from which the person suffers, and the accident stated to have occurred.

Insurable Interest.—A person insures his life either for the benefit of others at his death or of himself at a given age. When a man insures his own life, the insurers possess the most certain proof possible, that he (the insured) has "*a real insurable interest*," or "a lawful pecuniary interest" in its preservation. And this is a necessary condition of all life assurance. (*Cases* 38 and 43.)

But occasionally the insurance on one person's life is effected by a second person. Thus, if x insures a's life, the question is—what real insurable interest has x in a's life? Thus 14th George III. c. 48, enacts that "No insurance shall be made on the life or lives of any person or persons, or on any other event or events whatsoever, wherein the person or persons for whose use, benefit, or on whose account such policy or policies shall be made, shall have no interest." One person, however, may insure another person's life, provided it can be shown that his money advantage is greater by the person whose life he insures living, than what would accrue by his dying. (*Case* 2.)

Another difficulty, however, occurs here from the negotiable nature of policies. A policy may, and frequently does, fall into the hands of one who knows nothing whatever of the insured, but who is nevertheless bound, lest the policy lapse, to pay the premiums regularly so long as the insured lives. Thus the purchaser of the policy seems to have, and as a fact has, a real insurable interest in the *death* of the insured. Such a bartering in life policies is most objectionable. If the assignment of a policy to another party be permitted, it should, to prevent crime, be limited (as it is when an insurance is primarily effected) to those only whose interest is in the life of the insured.

Life Insurance Payable at Death.—In such cases the onus of proving the death rests with the executors, or with those who benefit by the death. In *Case* 1 the plaintiffs failed to prove the death, and consequently lost their case.

Proof of death being complete, the death is regarded as due to natural causes unless the contrary can be shown. Thus the onus of proving that the death was not natural rests with the insurers if they allege such to be the case, the other side not being called upon to prove that it was natural, save as a means of defending the action. Further, the proof that it was other than natural must be by direct, and not by mere inferential evidence. (*Cases* 45, 48.) It is clear, therefore, that in this respect the representatives of the insured have a decided advantage over the insurers.

As a rule, if a person is not heard of for two or three years, offices pay the insurance. In *Case* 67 a claim was resisted after an eight years' absence, the judge in the inferior court directing the jury that they must find for the company, unless they were satisfied that the insured had not been heard of for *seven* years. This the superior court overruled, and stated that the jury should have been directed to find for the plaintiff, unless the defendants (the insurers) adduced sufficient proof of the insured having been seen or heard of during the preceding seven years. Thus, after seven years, the onus of proving that the

insured is alive, rests with the insurers and not with those who claim the money. (See page 23.)

In all contracts, each party must comply with the conditions of the contract. The conditions usually required of an applicant, and on the fulfilment of which the insurers assess the life and grant a policy are as follows:—

(1.) *That the applicant shall not conceal from the insurers any disease from which he knows himself to have suffered or to be suffering, and shall not conceal any symptoms of which he is cognizant, indicating a possible attack of disease—in other words, any tendency to disease.* (*Cases* 3 to 27, 35.)

The directors of the company, in order to convince themselves on these points, require that the applicant shall furnish them with the names of all his medical attendants, from whom they may learn details respecting his past health, and also that he shall undergo an examination by their own medical officer, who may advise them as to his present condition.

It may be worth remarking here, that where a medical man is appealed to by an insurance company respecting the health of one of his patients desiring to insure, that, leaving the insurers out of the question, justice to the insured, to the survivors, and to himself, demands that he should report without a shadow of concealment. Unless he is prepared to do this, he had far better decline to report altogether. Further, he is not justified in reporting as the private medical adviser of the person whose life is in question, unless he has the authority of his patient to do so.

The phrase "*any other disease or disorder tending to shorten life,*" or similar words commonly added to a list of specifically mentioned diseases, respecting each and all of which the private medical adviser is asked to say whether the applicant has suffered, is a frequent source of litigation. The Courts, however, have generally held that this phrase is to be taken to include only the diseases that as a rule *do* shorten life, and not those that, under some remarkable or exceptional conditions, *may* shorten life. Thus, as the learned judge (Chambre) in *Case* 18 remarked, "All disorders, even the most trifling, have a tendency to shorten life—for instance, corns may end in mortification." Because a man who had dyspepsia had not declared it, the policy was not, therefore, rendered void.

But the applicant is required to do more than merely declare his state of health on the day he makes application. He must also state any illness he may have had in the course of his life, and any tendency

to disease, or symptoms indicating disease, of which he is cognizant. Thus a man may have had a lung complaint from which for a time he seems to have recovered. During this interval of health he might have effected an insurance. If hereafter phthisis suddenly developed itself, the policy would be void unless he had mentioned his previous lung complaint. This, however, must not be taken to imply that every little trivial illness is to be stated. (See form of Report.)

Although a failure to disclose the symptoms of existing disease renders a policy void when the policy is granted on the accuracy of statements made by the applicant or his friends (*Cases* 58, 59), the onus of proof as to the fraudulent nature of the suppression on the part of the insured, rests with the insurers. (*Case* 13.) And further, the Court requires that the evidence proving such fraudulent suppression should be more than mere probable or presumptive evidence. (*Cases* 4, 11.) Provided a man at the time of insuring be "in a reasonably good state of health," the existence of some latent disease unknown to himself would not invalidate the policy. Thus in the case of gout (as the Lord Chief-Justice remarked in *Case* 15, and Lord Mansfield again in *Case* 14), it must be sensible gout, and not some mere suspicious symptoms, only possible of detection by a more than ordinarily shrewd observer. It was held by Cockburn, Chief-Justice, Crompton, J., Blackburn, J., and Mellor, J., that on the construction of the particular declaration in *Case* 15, the policy would not be rendered void by a misrepresentation, unless such misrepresentation was wilful and designed.

Lastly, the suppression of the mention of a disease from which the insured is suffering invalidates the policy, equally whether the person die of the disease or not. Thus in *Case* 6, the person died of apoplexy, but the Court declared the policy void, because the insurers had not been informed of epileptic fits from which the deceased had suffered previously to the insurance being effected.

(2.) *That the insured neither conceal, nor misdescribe, his or her actual bodily condition.*

Thus in *Case* 3, the life of a speechless person was insured, the cause of the inability to speak being certain cerebral conditions which had not been stated. In this case the plaintiff elected to be nonsuited. In *Case* 23 again, the concealment of incontinence of urine, which had existed from boyhood, resulted in a verdict for the Company, whilst in *Case* 7 the concealment of prostatic disease and of incontinence of urine, was decided against the Company. It was argued

in the latter case that so far from prostatic disease diminishing the chance of life, it was usually a disease of old age.

Under the head of the concealment of bodily condition may be included certain obstetric concealments. Thus in *Case* 21, the concealment of a lacerated perinæum and of a uterine displacement invalidated a policy. In *Case* 20 the concealment of the previous birth of a child constituted the ground of an action, the insurers again obtaining a verdict in their favor.

(3.) *That the insured state accurately the names of one and all the medical men that have attended him.*

A policy would be vitiated by the insured saying he had had no medical attendants if he had. (*See Cases* 9 and 10.)

Again in *Case* 8, Lord Tenterden remarked that to refer to one medical man whom the insured knew would speak well of his health, and not to others whom he knew could not report favorably (although the insured did not die of the disease for which they had attended him), would vitiate his policy.

Similarly, for the insured to refer to a practitioner who had attended him three years previously, and to omit to mention one who had attended him more recently (*Case* 33), or to refer the office to a practitioner who had attended him many years for mere trivial complaints, and to omit one who had attended him, even though for a short period only, for a serious disease (*Case* 6), would equally render the policy void.

(4.) *That the insured detail accurately his applications, and the results of those applications, to other insurance offices.*

The insured must not conceal the results of his applications to other offices, whether they accepted him or not. If they accepted him he must state whether he effected an insurance, and at what rate, and if not why not. Thus in *Case* 15, the insured reported that he had been accepted by another office, whereas the truth was his life had been declined by the directors, although it had been recommended for acceptance by the medical referee. The jury in this case found that the reply was untrue. If an insurer, however, *withdraws* an application before it has been submitted to the board of a company, it is not then usual or necessary to mention it.

(5.) *That the insured describe accurately his business or profession.*

Different businesses and professions have different degrees of risk, and are therefore charged at different rates. In some cases, as has

been already pointed out (pages 8, 9), a business (independently altogether of the state of the applicant's health) will be a sufficient reason for an office declining a life.

(6.) *That the applicant accurately state his age.*

(7.) *That the applicant conceal nothing respecting his habits.*

There must, it is understood, be no concealment, although the special habit be not specifically included in the list of questions. Further, the true answers as to habits prejudicial to health, in many cases, are known only to the applicant.

Of these habits a few demand further consideration :—

Intemperance.—(*Cases* 26 to 34, 36.) It is difficult to say in words what constitutes intemperance. This difficulty of course opens a door to much discussion and difference of opinion. (*Case* 31.) An occasional "drinking bout" does not make a man in strict phrase "intemperate." Again, a habit of indulgence which would constitute intemperance in one man, may not constitute intemperance in another. Hence for insurance purposes the true question is—not what constitutes intemperance generally, but—is there reason to believe that the applicant takes more alcohol than his constitution will bear ? In this matter, *the general circumstances of a man's life* must be considered. Much beer and much exercise is a totally different combination to much beer and sedentary habits. Hence it is evident that in insurance cases, physician and jury must consider the word "intemperance" as a habit prejudicial to the life of the special individual, and not in any broad and general sense. If one man drinks a glass of wine daily and it makes him intoxicated, he is intemperate if he continues to drink that one glass of wine. But if another man drinks six glasses daily and they have no bad effect on him, but rather the reverse, he is not an intemperate man even if he continues to drink six glasses daily.

Again, intemperance may have remote and secondary, as well as immediate and primary, effects. These secondary results of intemperance have proved subjects of inquiry. (*Cases* 27 and 28.)

Can a man be intemperate and not ultimately suffer ? This question may arise in cases where the insured takes out a policy just at the commencement of the period of his intemperance. And to it, there can be but one answer—No. In *Case* 31, the medical man stated that he did not mention occasional outbreaks of drinking, because he thought they had no bad effect on the applicant's health. He was manifestly wrong in concealing it.

Opium-Eating is a habit which must be mentioned. (*Case* 37.) No

doubt there have been cases where opium has been taken for a long time without its doing any manifest harm. Further, it is a habit which (unlike alcoholic intemperance) may not reveal itself to the professional examiner. (Page 8).

Total Abstinence, Excessive Smoking, and Vegetarianism (*Case* 17) are habits more or less unusual, and should be noted by the applicant in his insurance paper to avoid possible discussion in the future.

In cases bearing on concealment of all kinds some such questions as the following are usually submitted to the jury for their consideration:—

(1.) Were the answers given untrue—(*i.e.*, either that material facts were suppressed or false statements made)?

(2.) Were the statements to the knowledge of the insured misrepresentations or suppressions?

(3.) Were they *material*—(*i.e.*, having regard to Lord Denman's ruling that a man is not bound to volunteer a statement of every circumstance that anybody might afterward think likely to affect the risk of his life)? (*Case* 30.)

(4.) Was the policy procured by such misrepresentations? In all contracts there must be the most perfect frankness on both sides (*uberrimæ fidei*).

Insurance and Suicide.

Every policy of life insurance contains certain provisions, the exact words differing in different policies, but for the most part to the effect that the policy will become void "if the insured commit suicide," and in some cases is added, "die by the hands of justice." (*Case* 44.)

If then a person be found dead, questions *re insurance* may arise as follows: Was the death (α) accidental or suicidal, (β) natural or suicidal, or (γ) homicidal or suicidal?

(α.) Was the death suicidal or accidental? *Case* 48, where death was the result of gunshot wounds, and *Case* 46, where death occurred from drowning, are illustrations of actions at law arising out of this question.

Case 50 illustrates how the act of suicide may be so arranged as to simulate homicide, and thus to defraud a Company.

(β.) Again, the question may arise whether a death be suicidal or natural? (*Case* 45.)

The onus of proof that the death was not natural, in other words (in the case we are considering) was suicidal, rests as we have said

with the insurers. Further, they are bound to prove that it was not natural by more than mere inferential evidence. (*Case* 48.) Here, indeed, is a difficulty with which an insurance office has to contend. Even the verdict of a coroner's jury in no respect binds either the insurance office or those who will benefit by the death. Thus because a coronor's jury finds a verdict of *felo de se*, a company is not excused from paying, any more than because they return a verdict of death from natural causes, can the relatives of the deceased necessarily recover? (Stormont *v.* Waterloo A. Co., 1 F. and F. 22.)

(γ.) Further, the question of suicide or murder may occur. Such a case, however, usually comes before the Court as a criminal charge against the person who both benefits by the death and is suspected of committing the murder, rather than as a matter of contention respecting the liability of the Company. (*Cases* 38 to 43.) If the insured be murdered, the office is clearly liable. In a French case (*Case* 42) however, although the prisoner was acquitted of murder, a verdict was for good reasons given for the office. In cases of this nature the chief question involved will be the pecuniary insurable interest of the person suspected of committing the murder, and to this point the evidence is usually directed. The interest may be direct, as when the murderer is the person who will receive the money, or it may be indirect, as when he acts as an agent for the person who will.

We now come to a far more difficult question. Given a case of suicide, was it the intentional act of a sane person, or the act of an insane person? The real difficulty lies in the circumstance that death from insanity does not exempt the insurers from paying, whilst suicide does. If then suicide be the result of insanity, are we justified in regarding insanity as the cause of death, and the suicide merely as one of the results of the insanity? (*Case* 49.)

The general ruling on the provisos of English insurance policies may be thus stated: "If the insured destroy himself intentionally, whether he be sane or insane, the policy is void; but if he destroy himself unintentionally, whether he be sane or insane, the insurers are liable. The onus, however, to prove the act unintentional, rests with those who will benefit by the policy."

This ruling, however, suggests two questions:—

(1.) Does not suicide necessarily indicate insanity?
(2.) If the person be insane ought the policy to be forfeited?

(1.) *Does not suicide necessarily indicate insanity?*

On this point the law is clear. Suicide is a felony unless there is

clear evidence of unsound mind. If two people agree to commit suicide and only one dies, the survivor is deemed guilty of murder. Thus it was ruled (R. *v.* May, *C. C. C.*, Nov., 1872) that "Any person aiding or abetting another in committing suicide is guilty of murder, and it cannot make any difference if the two agree to commit suicide together. In this case if one of the two causes his own death, and the other is present at the time aiding and abetting him, and attempts also to kill himself but fails, the second is guilty of murder, for the attempt at self-destruction of course does not affect the crime committed against the other."

It is clear therefore that the law does not regard suicide as necessarily a proof of a person being insane. With this, as medical jurists, we entirely agree.

(2.) *If the person be insane and commit suicide, ought the policy to be forfeited?*

As the law stands, *intentional suicide*, whether by a sane or by an insane person, vitiates the policy.

The words "sane" or "insane" are sometimes inserted, or the conditions otherwise worded, so as to include all cases of self-destruction, whether felonious or otherwise. And this is done because the conduct of insane persons seems in some degree to be under the control of their hopes and fears, and moreover their affection for others will often exercise a sway over their minds, when fear of death or personal suffering has no influence. Hence by imposing such conditions, the insurers place a certain restraint over the mind and conduct of the assured, whilst they do not exempt from a pecuniary interest in the continuance of his life, those on whose watchfulness it may depend.

In *Case* 46, where a man came to his death by drowning, the proviso in the policy was, "Unless he should die by his own hands." The question before the Court was—Considering the act of the deceased in conjunction with his previous conduct, did he drown himself knowingly and intentionally (because if so the policy would be clearly void), or did he know right from wrong at the time that he committed the act? The jury found, "That he intended to destroy himself, but that at the time he did not know right from wrong." On this verdict, judgment was given for the plaintiff, but on application to the Court by the insurance office, a rule *nisi* to allow the matter to be reconsidered was granted. The case was ultimately compromised.

In *Case* 47, the proviso named in the policy was "Suicide." The man poisoned himself with sulphuric acid, and the question arose whether or not he was sane or insane at the time? The judge (J.

Cresswell) directed the jury that, "Even in this case, suicide would not vitiate the policy, unless at the time the person was an accountable moral agent and able to distinguish right from wrong." In other words, they were directed to distinguish between suicide, the act of an insane person, and suicide, "a felonious killing." On appeal, however, this view was reversed, the judges differing. *The one side* (the majority) were of opinion that suicide meant "intentional self-destruction," independently of whether the person was or was not sane, whilst *the other side* (the minority) were of opinion that, if the act was not the act of a sane and reasonable being, it was not suicide within the meaning of the proviso, but that the death was the result of disease affecting the reason, suicide being one of the results of the disease.

In *Case* 47, Pollock, C. B., made the following remarks:—"In the eye of the law a man is either compos mentis and responsible, or he is non compos mentis and not responsible. It is admitted that the act of a raving madman, or of a patient under the influence of disease, is protected by the policy, if the consequences are not foreseen and intended. So if insanity should produce delusion and deprive a man of the use of his ordinary senses, and the party should mistake a deadly weapon for an instrument of music and fancy he was playing upon it when he was destroying his own life, this would be committing suicide within the proviso of the policy. But what if the delusion, instead of applying to a pistol or other instrument of death, applied to the man himself? Suppose he believed he was Marcus Curtius and ought to leap into a gulf, or that he was one of the Decii and must sacrifice himself for the benefit of his country? What if he fancied himself an apostle, and that it was his duty to die the death of a martyr? What sound philosophy is there in making a distinction between a delusion about a pistol and a delusion in respect of the man against whom it is to be directed?—or what distinction can be taken between physical blindness, which, leaving the man the use of his senses and a knowledge of the physical consequences of his acts, has deprived him of the judgment which should control and govern them, and the want of all sense by which to perceive their moral consequences? It may be said that when the delusion extends to the character, office, or condition of the party, so that he mistakes his identity, he does not mean to kill himself, and in such case the office would be liable. But how far is this to be carried? Suppose under a delusion he believed that he had committed a crime for which he ought to put himself to death, and this was the result of insanity; is this a mistake of his identity? In my opinion such subtleties as these ought to find no place in the decision of such a question as the present, in which is involved (from

the present extensive practice of life insurance) the peace, the happiness, and the security of thousands of families. In my judgment, if death be the result of *disease*, whether affecting the *senses* or the *reason*, the insurance office is liable under this policy. The act which is not the act of a sane, responsible creature, but is the result of any delusion or persuasion, whether physical, intellectual, or moral, is not the act of the man."

Again, in the case of "Horn *v.* Anglo-Australian Life Insurance Company" (30 *L. J.*, *ch.* 511) it was held that the policy was not rendered void by the suicide of the insured while in a state of insanity; but in this case the policy contained no proviso that the assurance should be void in case of suicide.

It may be worth recording that in the case of "Dufaur *v.* Professional Life Insurance Company" (27 *L. J.*, *ch.* 817), the policy contained a proviso, that if the insured should commit suicide it should be cancelled by the return of the premiums, except the policy should have been legally assigned. It was held that to commit suicide was equivalent to dying by his own hand without reference to the moral state of the mind of the deceased.

It appears to us that if a person is clearly proved to be of unsound mind, and in that condition commits suicide, it is fair and reasonable to regard the suicide as one of the results of a diseased and unsound mind, and not as an act which is the exercise of an intention, or in any respect whatsoever of felonious killing. It would no doubt be right to require that the onus of proof that the man was insane at the time, should be thrown on those who would benefit by the death.

II.

Presumption of Death.

When a person goes abroad, and has not been heard of for a long time, the presumption of death arises at the expiration of seven years from the period at which he was last heard of. The same rule holds good generally with respect to a person who has gone away from his usual place of resort, and of whom no account can be given. (*Cases* 60 to 67.)

If it be contended that the individual was alive any day during the seven years, it is incumbent on the person who asserts it to establish the fact affirmatively. (*Cases* 64, 65, 81.)

The question, therefore, for those discharging the functions of a jury is, whether the evidence of the person having been seen or heard of within a certain time, is strong enough for them to say that such person was alive at that time, and the judge will direct the jury that if there is no evidence, or if they do not credit the evidence given of the person having been seen or heard of alive within seven years, the presumption of law that he is dead must decide their verdict. Thus the presumption of death must depend on general evidence. The very word "presumption" implies supposition, as opposed to demonstration.

It will be remarked that in *Case* 63, the Court for Crown Cases Reserved held, that there was no presumption of law that life continued for seven years, or for any other period after the time of the latest proof of the life of the party, and that it was a question of fact for the jury under the circumstances of each case. The explanation of this apparent contradictory ruling is, that it was delivered in reference to a prosecution for bigamy. Now the gist of the offence of bigamy is, the contracting a second marriage during the continuance of the first, and it is for the prosecution to prove that the prisoner has done so. In this case evidence was given of the first marriage, but none that at the date of the second marriage, the prisoner's first husband was alive;—hence the prosecution failed to prove the facts necessary to support a conviction.

By 24–25 Vic., c. 100, s. 57, it is provided that a person cannot be convicted of bigamy, if such person proves that his or her husband or wife has been continually absent for the seven years then last past, and has not been known by such person to be living within that time. (*Cases* 61 to 63.)

In cases where questions of *heirship* and *property* are involved, the

Courts have not considered even seven years' absence to be necessary. Thus in *Case* 68, probate of a will was granted after only two years' absence. This course is manifestly just. At the same time it is equally just, and the practice of the Courts, that a right to property once acquired should not be averted from the rightful heirs on *mere presumptive* evidence. (*Case* 73.)

In *life insurance cases* the presumption of death is often a point at issue. (*Cases* 67, 69, and 70.) As a rule, however, insurance offices pay policies after the lapse of a year or two. (See page 13.)

In the case of a missing ship (*re* Hutton), bound from Manilla to London, on which the underwriters had voluntarily paid the amount insured, the death of those on board was presumed by the Prerogative Court after two years, and administration was granted accordingly.

Although the presumption of life ceases at the expiration of seven years from the period at which the person was last heard of, nevertheless this presumption does not imply at what date during the seven years the death occurred. There are recorded instances where the Court has stated whether the presumption is in favor of death before or after a certain date. (*Cases* 66 and 79.) In such cases the state of health of the person when last seen, generally constitutes an important consideration. This would involve medical evidence as to the probabilities of life in a person afflicted with a disease from which the individual in question was known to have suffered. (*Case* 66.) Or, again, evidence being given that a person was in receipt of an annuity, which he had drawn regularly, until a certain date, after which nothing more was heard of him, the Court has held that the person may be presumed to have died before the date when the last portion of the annuity became due. (See *Cases* 66 and 79.)

III.

Presumption of Survivorship.

Cases are numerous where questions relating to "the presumption of survivorship" have come before the Courts. Father and son, for instance, perish by a common accident. The question which survived the other is important, because if it be the son, even if the survival be but for a moment of time, "his wife shall have dower for the lands descended the instant the father died." The question of survivorship on one occasion arose in the matter of a father and son who were hanged together, the plaintiff in the action being the son's wife. (*Case* 83.) Similarly, it may occur in the case of *partners*, where the interest of the deceased lapses to the survivor. Similarly, again, in the case of a testator and a legatee, for if the legatee dies first, the legacy lapses, but if the testator, the executors of the legatee can claim. Again, a man who marries a woman possessed of freehold property (not specially settled by marriage articles) has no claim on the estate if she dies, unless he has a child by her capable of inheriting, and actually born during the life of the mother. (Tenancy by courtesy.)

This subject divides itself under two heads—

(A.) *Questions of survivorship where two or more persons have met their death by a common accident.*

(B.) *Questions of survivorship where the precise time and date of death of one of the parties is known, whilst that of the other is only presumptive.*

(A.) *Questions of survivorship where two or more persons have met their death by a common accident.*

The old Roman Law on this subject is important as more or less governing all the Courts (English and Foreign) even to the present day.—(*Domat, C. L.*, pp. 652–653; *Hunter, R. L.*, p. 745.)—The rule, subject to the exceptions to be presently stated, was that when there was no evidence to show which of two or more persons died first, the law would not presume that one died before the other. (*D.*, 34, 5, 18.) This rule operated therefore in favor of the person in possession —in other words, in favor of the person that did not require to invoke

the aid of the law. *For example*, a gift (which was valid unless revoked in his lifetime) was made by a husband to his wife. Both husband and wife perished together. It was held that the gift was valid because the donor did not survive to reclaim the gift.—(*D.*, 34, 5, 8.)

But to this rule there were certain exceptions that seem to have been dictated by a desire for the most part to prefer certain claimants to others:—

(1.) When a child above the age of puberty perished along with a parent, and there was no evidence to show which survived, it was presumed that the child survived the parent.—(*D.*, 34, 5, 22.)

(2.) When a child under the age of puberty perished along with a parent, the child was presumed to die first.—(*D.*, 34, 5, 23.)

(3.) A person is burdened with a trust if he dies leaving no child surviving him. Both he and his only son perished together. It was presumed that the son died first, and thereby the trust took effect. This is a presumption in favor of a trust.

In the case of husband and wife, the husband was presumed the survivor. Beck quotes the following from the "Digest," lib. xxxiv. tit. 5, *de rebus dubiis*:—"Cum pubere filio mater naufragii periit, cum explorari non posset, uter prior extinctus sit, humanus est credere, filium diutius vixisse. Si mulier cum filio impubere naufragio periit, priorem filium necatum esse intelligitur," etc. The decisions given by Zacchias and the older writers were essentially founded on the same principles.

The *French* law, as contained in the Code Napoléon, is as follows:—

I. If several persons, naturally heirs of each other, perish by the same event, without the possibility of knowing which died first, the presumption as to survivorship shall be determined by the circumstances of the case; and in default thereof, by strength of age and sex.

II. If those who perished together were under fifteen years, the oldest shall be presumed the survivor.

III. If they were all above sixty years of age, then the youngest shall be presumed the survivor.

IV. If some were under fifteen, and others above sixty, the former shall be presumed the survivors.

V. If those who perished together were over the age of fifteen,

but under sixty, the males shall be presumed the survivors where the ages are equal, or the difference does not exceed one year.

VI. If they were of the same sex, that presumption shall be admitted which opens the succession in the order of nature. Of course the younger shall be considered to have survived the elder.

By Section I. of the French code, if definite evidence can be produced as to who was the survivor, the case is then decided on its merits, but failing this, Sections II. to VI. lay down the precise conditions of age and sex on which survivorship is to be decided. Sections II. to IV. relate specially to *age*. Sections II. and III. are (regarded medico-legally) undoubtedly sound, but Section IV. appears to be scarcely so satisfactory, because it draws no distinction between an infant of one year old, and a man of sixty-one years of age. The latter may fairly be supposed to have a better chance of life than the former, whilst Section IV. actually gives the advantage to the infant. Sections V. and VI. have special reference to *sex*.

The *Prussian* Common Law (Part I., tit. 1, § 39) and Civil Code (Arts. 720, 721, 722), quoted by Casper (Dr. Balfour's Trans., vol. i., p. 14), are identical in spirit with the Code Napoléon.

By the *Mahometan* law of India, when relatives perish together "it is to be presumed that they all died at the same moment, and the property of each shall pass to his living heirs without any portion of it vesting in his companions in misfortune."

The *English* law in these cases (which always leans toward the view that matters of this kind are questions of fact, to be decided according to the balance of evidence in each particular case, and not by any artificial or strictly formulated presumption), is now definitely settled by the decision of the House of Lords, in Wing *v.* Angrave (8 H. L. C., 183). In this case husband, wife, and children were swept off the deck of a vessel by one wave, there being no evidence to show that one was seen alive after the other. It was proved that the husband was a strong man and a good swimmer, and that the wife was a weak and delicate woman and could not swim at all. In spite of this, however, the House of Lords would not assume that one survived the other, but decided—

(i.) That there is no presumption of law as to survivorship arising from age and sex, as to persons whose death is occasioned by one and the same cause.

(ii.) Nor is there any presumption of law that all died at the same time.

(iii.) That the question is one of fact depending wholly on evidence. If the evidence does not establish the survivorship of any one, the law treats it as a matter incapable of being determined.

(iv.) That the onus probandi rests with the person asserting the affirmative.

On the other hand, although there may be no presumption of law as to the survivorship of persons killed by a common accident, based on age, sex, or health, yet these are matters of importance to be considered by those who have to discharge the function of a jury. And in thus deciding questions of survivorship the chief matters that ought to influence their decision are as follows:—

(1.) First in importance is the *Degree of Danger* to which the several persons were exposed.

(2.) Next to degree of danger, *the Age of the several persons killed* must be considered. (*Case* 85.) Thus—in the case of a parent and of a child under puberty dying by the same accident, the latter in civil law is supposed to die first. Two cases are recorded, the one (1) of a mother and infant being shipwrecked, and the other (2) of a mother and infant being killed by lightning, where the parents, in both instances, were deemed the survivors (*Zacchias*, Vol. I., pp. 440, 441).

In a case that occurred in France a woman and her two children (æt. eight and two years respectively) were murdered. The husband claimed the property, arguing that the children were the survivors. The Court agreed to this view of the case on the ground that the murderers would naturally first destroy the person who resisted the most, and that that person was probably the parent (*Foderé Causes Célèbres*, II., p. 218).

A remarkable case is recorded before a French Court in 1658. A father and his son (who had arrived at maturity) were killed in battle (Dunes). On the same day and at the same hour that the battle commenced, the daughter took the veil, by which act she became "dead in law." The question before the Court was—Did the father, the son, or the daughter survive? The Court decided in favor of the son, on the ground that the daughter died instantly—her vow being voluntary—whilst of the father and son, both of whom probably struggled for life for a time from the wounds they had received, the presumption

of survivorship was in favor of the son, considering his youth and strength.

Admitting that, given an equal degree of danger occurring to an adult between 25 (when adult vigor is reached) and 55 (when adult vigor commences to decline), and to one either above the age of 55 or under 25, the probability of survivorship will be in favor of the adult between 25 and 55, nevertheless we fail entirely to see any reason to presume survivorship on the ground of age alone (*i.e.*, strength and power) in the case of adults between 25 and 55.

(3.) Again, the question of *Sex* must be considered. The male, as the stronger, is always supposed to have a better chance of life than the female, "the weaker vessel." Thus in Selwyn's case (*Case* 75) where husband and wife died by drowning, the result of the same accident, it was decided that the husband, being the stronger of the two, survived. (*Case* 73.)

In *Case* 74 the decision was similar, notwithstanding that the wife was proved to be a robust woman and the husband weakly. Sir John Nicoll remarked that inasmuch as the presumption of law was always in favor of the heir-at-law with regard to freehold, and of next of kin with regard to personal property, it was incumbent upon the representatives of the wife to prove her survivorship, and repel the presumption of the husband being the survivor. This they had not done—hence the verdict.

Health, however, may not be an altogether unimportant matter to be considered in such cases. Thus a curious case is recorded by Beck, where both husband and wife were found dead (it was believed) from eating poisonous mushrooms. Zacchias (Concilium, No. 85) decided that the wife died first on the following grounds: *The husband*, though *sixty years of age*, was robust and healthy, and from the depositions of the servants appears to have eaten but few of the mushrooms. *The wife*, on the contrary, although *only forty*, was asthmatic, and subject to affections of the stomach, and moreover had eaten largely of the mushrooms and of other indigestible food. Zacchias contended that a poison which acts violently on the organs of respiration would soonest destroy one already diseased in these parts. Hence he decided in favor of the husband being the survivor, notwithstanding his age.

In *Case* 76 the evidence was of such a nature that the wife was declared to be the survivor. Here the evidence clearly indicated that the husband died first. (See also *Case* 82.)

Health, sex, and age, however, are so closely related that in con-

sidering a case of survivorship it is difficult, if not impossible to separate them. A curious illustration of this is presented to us in *Case* 71. A gentleman with his wife and daughter were wrecked. If the husband survived, his nephew would be entitled to the property. If the daughter survived, the maternal uncle became the rightful heir. In this form the case came before the Court, a representative of the wife also putting in a claim. The maternal uncle argued that the husband was old and ill-prepared to battle with the storm, whilst the daughter was young and would probably fight for life. Hence the presumption of survivorship was, it was contended, in favor of the daughter. On the other hand, the nephew argued that the husband was a man of courage (a General in the army) and accustomed to danger, and in all probability outlived both wife and daughter. It was further suggested that the chances were that with manly courage he would have come on deck the instant danger was suspected, whilst the wife and daughter, with female timidity, would probably have remained in the cabin, their liability to perish being thereby increased. So close was the balance of dissimilar probabilities that Lord Mansfield advised a compromise, to which all parties agreed.

(4.) *The Cause of Death.*—This manifestly requires attention. We shall consider a few of these causes seriatim :—

(*a.*)—*Drowning, Shipwreck, etc.* (*Cases* 71 to 75.)—Here sex, age, strength, and position must be considered. As regards *sex* a man is more likely to be able to swim than a woman, whilst his clothes would be less embarrassing. At the same time a woman's breasts and particularly her clothes might buoy her up automatically when her strength was becoming exhausted. Of course, in the case of shipwreck, men are far more likely to be on deck than women, and therefore in a safer position in case of accident.

If the question of survivorship occurs in the case of two men similarly exposed and of similar strength, the presence of injuries must be carefully noted. Thus if wounds be found on the body of one, of such a nature as would interfere with his making efficient efforts to save himself from drowning, whilst there is an absence of wounds on the other, two questions will arise for consideration :—(1) Were the wounds received when the man first fell into the water? for if so, the presumption would be that he died first, the wounds adding to the chance of his dying rapidly, and preventing struggles for life; or (2) were the wounds the result of vehement and long-continued efforts to save his life? for if so, the probability then would be in his favor as survivor. Hence if wounds be found, it will be for the medical jurist

to consider the nature and precise cause of the wounds, in other words how far they were caused by, or interfered with, the efforts of the man to save himself.

In ordinary cases of death by drowning, several lives are frequently lost, from one after another jumping into the water to save those already submerged. The question in such case may arise as to the order in which the lives were sacrificed. If one of those drowned be known to be an expert swimmer, and there be found upon the body lacerations capable of explanation as resulting from violent attempts to save life, whilst a second is known to be unable to swim, the chances of survivorship are greatly in favor of the former. *Position*, again, may help our decision in such a case, more especially when the swimming capabilities of the persons respectively are known. For example, if two bodies are recovered, the one being that of a good swimmer, and the other not a swimmer, and if in the hands of the swimmer, portions of the hair or clothes of the non-swimmer are found, or if the arm of the swimmer is found tightly grasping the non-swimmer, the presumption of survivorship is again greatly in favor of the swimmer, and of his death having been caused in his efforts to save the life of the other.

(β.) *Smothering.*—In cases where several deaths occur from smothering (*e.g.*, such an accident as the falling in of a house, embankment, etc.) age, sex, mode of life, the relative strength of the parties, but above all the position of the bodies and the marks of violence upon them, must be carefully considered. As regards *position*, those nearest the surface probably lived the longest (*Case* 84); whilst with respect to *wounds*, if a body is found having a severe wound upon it, itself sufficient to destroy life almost instantaneously, the presumption of survivorship is rendered less difficult. (*Cases* 84 and 85.)

It may here be added that in all disputed cases of survivorship, the presence or absence of wounds must be carefully determined, and their precise importance in the special case carefully considered. (*Case* 82.)

(γ.) *A want of oxygen, and exposure to noxious exhalations.*—If the question of survivorship occurs in the case of a number of persons who have met their death from being packed in an imperfectly ventilated room (such as the Black Hole of Calcutta), or in a room where poisonous gases have found entrance, the *muscular development and strength* of the several parties must be first of all considered. But here some care is needed in drawing conclusions. Although muscular power and strength may on the one hand enable a person to get the best place (*i.e.*, where there is the most oxygen), still we must remem-

ber that on the other hand the demand for, and effort to obtain air is probably in proportion to its want, whilst the want is rendered greater by the intensity of the effort. Thus the loss by quiet and inactivity, may far more than counterbalance the gain by unrest and activity. Again, the *position* of the bodies when discovered is important. For example, one person may be found lying on the floor, and another off the floor, *e.g.*, on a bed, or one person may have occupied a place near a window or door, and another some distance off. The advantages of position will in such cases require consideration. Again, the *sex* of the several parties will be of importance. For, as a rule, women consume less oxygen than men, and therefore not only will the same quantity of air last them a longer time, but they will be able to breathe an atmosphere containing a less percentage of oxygen. Grey states that the proportion of females to males that are recovered after poisoning by carbonic acid is as 15 to 14; whilst Devergie places it as high as 5 to 4.

Thus in any given case, speaking generally, those who require least air will live the longest. Women therefore have the advantage over men, and some say (although I doubt its truth) children over adults. But those (whether male or female) nearest a place where fresh air finds entrance, are almost certain to survive the longest. (*Cases* 84 and 85.)

(δ.) *Cold.*—In cases where the question of survivorship occurs after the death of two or more persons from cold, the amount of clothing worn by each person and their physical conditions—*i.e.*, whether stout or lean—must be noted. Further, evidence must be sought as to the regularity of their lives, more especially with respect to the taking of alcohol. All these points being equal (viz., clothing, nutrition, and regularity of life), the presumption of survivorship will most certainly be in favor of adults over the extremes of age, and of males over females. Of the extremes of age, the very young suffer most from cold, and the very old from heat.

But in such cases there are two modifying conditions that deserve particular attention, viz., poverty and intoxication. The injurious effects of cold on the badly fed is usually very marked, but its action is specially severe on those addicted to alcohol, on whom nervous energy has been diminished by a previous state of morbid excitement. Again, those who have taken narcotic poisons as a rule suffer intensely from severe cold. This circumstance is of importance, seeing that a person who has gone out on a cold night after having taken a dose of opium, which under ordinary conditions would produce little or no effect, might fall down comatose and die from the combined action of

exposure to severe cold and the effects of the opium. In other words, the narcotic action of the opium would be intensified by the action of the cold, which itself acts as a powerful agent in inducing languor, loss of sensibility, and sleep.

(ε.) *Heat.*—No rules can well be laid down respecting survivorship in cases of death by heat, but it is just possible that as the young and the old suffer more from cold than adults, so they may be able to withstand a greater amount of heat than adults. General experience seems to prove this to be the case. (See *Index.*)

(ζ.) *Lightning.*—Possibly the proximity of certain bodies to dangerous places, and to substances that are conductors of electricity, may assist us in forming some idea as to the order of death. Collateral circumstances may also be worthy of consideration, such as the existence of metallic and other conductors about the body. If the clothes of a person be found torn to shreds, the body contused or lacerated, and metallic substances on the person fused and highly magnetic, instantaneous death is probable; whilst, on the other hand, if there is an absence of such conditions, a less rapid termination is indicated. But exceptions to this rule are, it must be admitted, numerous, and the question of survivorship in such cases is extremely difficult to determine.

(η.) *Poisoning.*—In these cases the general history, the kind of poison employed, the quantity taken, and the strength of the several persons poisoned, will be the chief points to be considered, but it is here more particularly (it has always appeared to me) that some definite law determining survivorship is required.

(θ.) *Starvation.*—In cases of starvation the presumption of survivorship would certainly be in favor of the aged,—who need less food and need it less frequently,—over adults, and of adults over children, who need most food and need it most frequently. In other words, death from starvation will supervene inversely to the urgency with which food is required—the child perishing before the youth, the youth before the adult, and the adult before the aged. For the same reason the female will probably outlive the male, seeing that women as a rule require less food than men.

Again, the proximity to, or the possibility of obtaining water must in these cases be considered. The presumption of survivorship is always immensely in favor of a person who, although he can get nothing to eat, can get water, over one who can get neither food nor water. At the same time it must be remembered that too much water hurries on histogenetic changes. (See *Starvation.*)

Further, in starvation stout people have a manifest advantage over

lean. The influence in such cases of certain diseased conditions must also be a matter for special consideration.

(ι.) *Death by Parturition.*—If mother and child both die in childbed without witnesses, the presumption is that the mother survived the child. For, *First*, there is a prima-facie probability of the child being still-born, and that a women in childbed without attention or attendance will be unable to render her child the assistance necessary for its preservation. *Secondly*, a large child, or external marks of a difficult labor, or the absence of the signs of respiration, would suggest the death of the child as occurring before that of the mother. Thus from both points of view, the presumption of survivorship in those rare cases where mother and child both die, is in favor of the mother.

We agree with most medical jurists, that those who assert that the child survived the mother should be required to adduce definite evidence of their contention. At the same time, it must be remembered that although the child may die from cold, or from suffocation, or from its being of unusual size, or from protracted labor, or from labor complicated with convulsions, or from pressure on the umbilical cord, or from partial detachment of the placenta, and other causes, nevertheless that the mother runs the risk (and that risk a very dangerous risk) of hemorrhage. Again, it is quite conceivable that a mother might give birth to a child and herself tie the cord, and then die of syncope from the exhaustion consequent on the effort, whereas the child would be temporarily safe. In a case decided by the Imperial Chamber at Wetzlar, in favor of the child being the survivor, it was urged that the mother sank exhausted by the pains of labor, and as a result that the child died for lack of nourishment.

(B.) *Questions of survivorship where the precise date and time of death of one of the parties is known, whilst that of the other is only presumptive.*

Of this nature *Cases* 77 to 80 are illustrations. We have only to remark that, in all such cases the decision must rest entirely on evidence. (*Case* 86.)

Case 76 is remarkable. An explosion occurred on a steamboat. The wife was seen alive, and was heard calling for her husband *after* the explosion, but the husband, on the contrary, was neither seen nor heard after the explosion. Thus, at least, the earliest time of the wife's death was known. The judge decided that from the evidence the presumption was that she survived her husband.

ILLUSTRATIVE CASES.

1. **Hiorns and Drew v. Railway Passengers' Insurance Company.**—(*Exchequer: Guildhall, Feb.*, 1862.)—Hiorns, single, æt. 26, insured his life against accident on Sept. 6, 1856. On Sept. 13th he went to Brighton, taking a return ticket. He had a bath on the morning of the 15th. In the evening of the 15th he parted from his friends, expressing his intention to go to his lodgings and to have a second bath before returning to London. He was seen to go toward the sea, but in spite of all endeavors was never heard of afterward. A bundle of clothes was found on the steps of a bathing machine the day he was missed, which were identified as belonging to him. On October 30th (45 days after his disappearance) a naked body was washed ashore at Walton-on-Naze, 150 miles from Brighton. His brother (the plaintiff in the action) stated at the inquest that to the best of his belief it was the body of Hiorns, but that positive identity was difficult, owing to the complete destruction of the features. The Coroner's jury found that the body was that of a person unknown.

The Company urged in defence at the trial that the whole thing was a fraud, and that Hiorns was alive. It was proved he was a bankrupt in 1855; also that he had effected several insurance policies in September, 1856, and made a will directing that the policies should after his death be realized to pay his debts. The jury were unable to agree. (Page 13.)

2. **Hebdon v. West.**—(3 *B. and S.*, 579.)—An insurance was effected for £2,500 on the life of a Mr. Pedder. The defendant (the insurance company) contended that the plaintiff, who was a clerk in a firm to which he owed £5,000, had no insurable interest in the life of Pedder. Pedder (being a member of the firm) had promised the plaintiff that he should not be asked for the money owing so long as he (Pedder) lived. Hebdon on this promise insured Pedder's life. It was held that the plaintiff had an insurable interest in the life of Pedder within 14 George III. 48, arising from the engagement by Pedder to employ him as clerk at a salary. (Page 13.)

3. **Von Lindenau v. Desborough.**—(*Atlas Office. Insurance on the life of the Duke of Saxe-Gotha. Oct.*, 1828. 8 *B. and C.*, 586. See *also* "*Med. Chir. Rev.*," Vol. XIV., p. 213 ; "*Lond. Med. Gaz.*," Vol. II., p. 669.)—The office (defendant) contested payment of insurance, on the ground that certain cerebral symptoms from which the Duke suffered had been concealed. Double the usual premiums had been charged because the Duke was speechless, but he had previously had cerebral symptoms, which had not been stated. The insured ultimately died of tumor of the brain, etc. The plaintiff elected to be nonsuited. (Pages 14, 15.)

4. **Walters v. Barker.**—(*Monmouth Assizes*, 1844.)—Payment of insurance contested on the ground that certain paralytic attacks, that had existed from an early age, had been concealed. No medical evidence was offered. Verdict for plaintiffs (executors of insured). (Pages 14, 15.)

5. **Case of the Sœur Fried.**—(See *Beck's Med. Juris.*, also *Tardieu* and *Ristelhueber's* "*Rapports et Consultations de Médicine Légale.*")—In this case the insured had suffered from hemiplegia and apoplexy ten years before insuring. This fact had been concealed from the office. The insured died from apoplexy two days after the insurance had been effected. The medical evidence was conflicting. (Page 14.)

6. **Insurance Office v. Executors of Mrs. Ralston.**—(*Glasgow*, 1837.)—(See *Taylor*, Vol. II., p. 618.)—Payment contested on the ground of the concealment of epileptic fits, etc. The insured died from apoplexy. Reference was given to a medical man who had attended her for ten years during which period her health had been good, but not to the physician in attendance for epileptic fits from which she was suffering at the time the insurance was effected. Verdict for the Company, on the ground of want of candor. (Pages 14, 15, 16.)

7. **Ross v. Bradshaw.**—(*Case of Insurance on the Life of Sir James Ross.*)—(1 *Black. Rep.*, 312.)—In this case an insurance was effected for one year, a warranty being given of good health. The insured died within the year, of malignant fever. The office contested payment on the ground that the fact of partial paralysis, with incontinence of urine and fæces, arising from a wound in the loins received in battle, had not been mentioned. It was proved, however, that his last illness had no connection with this incontinence, and that it in no way affected the life. Verdict for the executors of the insured. (Pages 14, 15.)

8. **Maynard v. Rhode and Others (Pelican Life Office.)**—Colonel Lyon's Case. (*Dr. Taylor*, Vol. II., p. 617. 5 *Dowl. and Ry.*, 266.) —Concealment of an illness and of the name of previous medical attend-

ants who had treated the insured for certain active diseases, such as inflammation of the liver, fever, and determination of blood to the head. A verdict was given for the defendants on the ground of concealment, although the insured did not die of the disease concealed. (Pages 14, 16.)

9. **Wilshere v. Brown.**—(*Exchequer, Dec.*, 1842, *before Lord Abinger.*)—Concealment of previous illness, and denial by the insured that he had consulted any medical attendant. Verdict for defendants (the office) on the ground of fraud. (Pages 14, 16.)

10. **Palmer and Fish v. Irving.**—Insurance on the life of one Howes.—(*Norwich Summer Assizes*, 1842 (?).)—Concealment of previous illness. The insured denied having ever had a doctor, whilst in fact three had attended him. Verdict for defendant (the office) on the ground of fraud. (Pages 14, 16.)

11. **Geach v. Ingall.**—(*Warwick Summer Assizes*, 1844.)—Alleged concealment of phthisis. Death four years after insurance. Verdict for plaintiff (the executor of the insured), chiefly on the ground that the Company's medical officer had examined him, and that the evidence of previous disease was at most presumptive. (Pages 14, 15.)

12. **Case of Mrs. Elgie (April, 1824.)**—Alleged concealment of phthisis. Verdict for plaintiffs (executors of the insured), the jury being of opinion that the concealment was not material. The medical evidence was conflicting. (Page 14.)

13. **Bailey v. Imperial Assurance Company.**—*Oxford Assizes*, 1869.)—Alleged concealment of phthisical symptoms, of which the applicant was said to have been informed one year previous to insuring. Verdict for plaintiff, chiefly on the ground that the medical man of the Company had failed to recognize symptoms of phthisis, and that the onus of proof that the insured knew of the phthisis when he applied rested with the Company. (Pages 14, 15.)

14. **Willis v. Poole.**—Life of Sir Simeon Sturt.—(*Park*, 935.)—Payment of policy contested by the office on the ground of concealment of gout. The insured died within one year of the policy being effected. Verdict for plaintiff (executor of insured). Lord Mansfield in this case said: "Such a warranty can never mean that a man has not in him the seeds of some disorder. We are all born with the seeds of mortality in us. A man subject to the gout is a life capable of being insured if he has no sickness at the time to make it an unequal contract." (Pages 14, 15.)

15. **Executors of Fowkes v. the Manchester and London Assurance Company.**—(32 *L. J.*, *Q. B.*, 153.)—Alleged concealment of gout. Verdict for plaintiffs, with point reserved. The life had been approved by the medical referee of another office, but was not *accepted* by that office as the insured declared. (Pages 14, 15, 16.)

16. **Sweet v. Fairlie (Globe Office.)**—(6 *Carr. and P.*, 1)—Life of one Abraham.—Concealment of previous determination of blood to the head, the person eventually dying of apoplexy. Verdict for plaintiffs (executors of insured). It was held that a policy is not vitiated by the insured failing to communicate his having been afflicted with a disorder tending to shorten human life, which was of such a character as to prevent the party from being conscious of what had happened to him while suffering under it. (Page 14.)

17. **Huntley v. the St. George Insurance Company.**—(*Newcastle Assizes,* 1858.)—Insured was a medical man, and died three months after the insurance had been effected. Payment contested, because of the concealment of Bright's disease and of diseased heart. Vegetarianism was supposed to have caused his ill-health. Verdict for plaintiff. [The Lord Chief Baron suggested that in future insurance companies should ask intending assurers, "Are you a vegetarian?"! !] (Pages 14, 18.)

18. **Watson v. Mainwaring.**—(Equitable Insurance Company.)—(4 *Taunt.*, 763.)—Payment contested on the ground of the concealment of organic dyspepsia. Verdict for plaintiff. The jury decided it was not organic dyspepsia, nor was it excessive dyspepsia from which the insured suffered. Application for a new trial refused. (Page 14.)

19. **Simcox v. Bignold.**—(*Chitty's Med. Juris.*, I., p. 235.)—Death of the insured resulted four years after insurance, from a fungoid tumor in the left kidney. It was argued that the tumor was of five or six years' growth, and was an incurable organic disease, and that the insured had been treated for it two or three years before taking out the policy. The case was compromised by the defendants refunding the premiums received. (Page 14.)

20. **Lefevre v. Boyd.**—Two brothers, named Edwards, induced Jane Lydia Simpson, their half-sister, to insure her life. A previous pregnancy and birth of a child, who died with symptoms of syphilis, not declared. Verdict for plaintiff (the office). The insured was pregnant by W. Reid Edwards, her half-brother! Medical evidence was given that the pregnancy was material under the circumstances. (Pages 14, 16.)

21. **Brembridge v. Hoare.**—(Sun Life Insurance Company.)—(*Court of Exchequer*, Feb., 1873.)—£5,000 on the life of a Mrs. Formby.—Concealment of laceration of perinæum, and of uterine disease and displacement. Verdict for office. The medical evidence in this case is voluminous. (See *Taylor*, Vol. II., pp. 619-621.) (Pages 14, 16.)

22. **Case mentioned by Dr. Taylor** (Vol. II., p. 617).—Alleged concealment of a scrotal tumor (? hernia). The insured died of strangulated hernia thirteen months after insurance. Verdict for plaintiffs (executors of insured) on second trial. Medical evidence conflicting as to whether at the time he insured the man suffered from a hernia or from varicocele, and his knowledge respecting it. (Page 14.)

23. **Leete v. The Gresham Life Office.**—Court of Exchequer, July, 1851.—(15 *Jurist*, 1161.)—£350 on the life of Giles Clement.—Concealment of urinary and prostatic disease existing from boyhood. Verdict for defendants. No medical evidence was offered on the part of the plaintiff, but counsel argued that prostatic disease did not shorten life, seeing that old men often suffered from it and yet lived on. (Pages 14, 15.)

24. **Executors of a Clergyman v. Providence Insurance Company.**—(*York Assizes*, 1835.)—Concealment of insanity. Verdict for plaintiffs. The jury found that insanity had no tendency to shorten life, a verdict entirely opposed to medical experience and known facts. (Page 14.)

25. **Huguenin v. Rayley.**—(6 "*Taunton's Reports,*" p. 185.)—(*Sarum Assizes*, 1815.)—Concealment of the fact that at the time of insurance the applicant was a prisoner for debt. Nonsuit on the ground that the omission by the medical men to state this was not by connivance. A new trial allowed on the ground that it ought to have been submitted to the jury whether such concealment was a material omission. (Page 14.)

26. **Evans v. Cox.**—(British Commercial Life Office.)—(*King's Bench, Feb.,* 1831.)—Insurance on the life of Ann Elsworthy.—Concealment of intemperate habits and of a previous attack of cholera. Verdict for plaintiff (executors of insured), but a fresh trial granted. (Pages 14, 17.)

27. **Wiggins v. Gresham Life Office.**—(*Bristol Summer Assizes*, 1872.)—Concealment of intemperance and of disease of lungs. Verdict for the office on the ground of the suppression of material facts. (Pages 14, 17.)

28. **Pole v. Rogers.**—(*Before Tindal, C. J., Feb.,* 1840.)—On the life of Peter Cochrane.—Concealment of intemperance, alleged to be the cause of hydrothorax, of which the insured died. Verdict for plaintiff (executor of insured). [See remarks of Solicitor-General. Taylor, Vol. II., p. 625.] (Page 28.)

29. **Jay v. Gresham Life Insurance Company.**—(*Before Baron Amphlett, Leeds Assizes,* 1874.)—Concealment of intemperance. Verdict for plaintiffs. (Page 17.)

30. **Rawlings v. Desborough.**—(3 *My.* and *C.,* 515.)—Life of John Cochrane.—Concealment of habits of intemperance. Verdict for plaintiff (executor of insured). Motion for new trial. The life had been declined by Mr. Travers for one office on the ground of previous delirium tremens. Lord Denman said a proposed insurer was not bound to volunteer statements of all sorts of things; but he was bound to conceal nothing when asked and to answer all questions truly. (Pages 17, 18.)

31. **Southcomb v. Merriman.**—(*Carr. and Mar.,* 286.)—The medical man admitted that the insured had had several outbreaks of intemperance, which he did not state because he thought they had no influence on the health of the applicant. Verdict for plaintiffs (executors of insured), but a rule for a new trial obtained. Twelve witnesses proved the applicant to have been very temperate, and twenty-one that he was the reverse! (Page 17.)

32. **Craig v. Fenn.**—(*Dec.,* 1841.)—Case of Hon. H. G. Talbot.—Payment disputed on the ground of intemperance having been concealed. Verdict for office. No answer being returned to question as to the temperate habits of the insured, the office charged a higher premium; nevertheless it was held that the habits of deceased ought to have been mentioned. (Page 17.)

33. **Hutton v. Waterloo Life Association.**—(1 *F. and F.,* 735.)—Alleged denial or at any rate concealment of delirium tremens. Further, the insured did not give the name of his usual medical attendant, but only of one that had attended him three years before the policy was taken out. The Company's own medical man described him as a "first-class" life. Verdict mainly for defendants. (Page 17.)

34. **Wheelton v. Hurdisty.**—(26 *L. J., Q. B.,* 265, *and* 27 *L. J., Q. B.,* 241.)—Life of Mr. Jodrell.—Concealment of intemperate habits and of delirium tremens. Company's own medical examiner certified the insured as a "first-class" life. Verdict for defendants. On appeal it was held

that the medical and private referees were not the agents of the assured, so as to make their fraudulent misrepresentation or concealment the act of the assured. "In cases where the representations of the referees are made the basis of the policy the answers of the referees are binding upon the insured." (Page 17.)

35. **Chattock v. Shaw.**—(Eagle Office.)—(1 *Moo. and Rob.*, 498.)—Life of Colonel Greswold.—The concealment of fits. Verdict for plaintiff. Where a policy of insurance contains a warranty that the assured has not been afflicted with, nor is subject to gout, vertigo, fits, etc., such warranty is not broken by the fact of the insured having had an epileptic fit in consequence of an accident. To vitiate such policy it must be shown that the constitution of the assured was naturally liable to fits, or had become so liable, by accident or otherwise. (Page 14.)

36. **Case against the National Insurance Company.**—(*Irish Rolls Court*, 1876.)—In this case the insured stated that he was in good health and not addicted to any habits tending to shorten life. The Company afterward discovered he was intemperate, and had had attacks of delirium tremens. This he denied having occurred before the policy was taken out. Judgment for the Company, the policy being declared void. (This is the first case where a policy was declared void during the lifetime of the person.) (Page 17.)

37. **Executors of Earl of Mar v. Edinburgh Life Assurance Company.**—(*Jury Court, Edinburgh*, 1830.)—Payment contested on the ground that the insured was an opium-eater, and that he drank to excess, both of which circumstances had been concealed. Verdict for plaintiffs, chiefly on the ground that the Company were not careful enough in making inquiries. (Pages 8, 17.)

38. **Wainewright v. Bland.**—(1 *Moo. and Rob.*, 481.)—Insurance on the life of a Miss Abercrombie in the Imperial Assurance Company by Wainewright, her brother-in law. Payment contested on the ground that the death probably arose from poison, that there had been misrepresentation, and that Wainewright had no lawful pecuniary interest in her life. Verdict for Insurance Office. Wainewright was afterward transported for forgery. He is said to have confessed that he gave strychnine to Miss Abercrombie and to two others. (Pages 12, 19.)

39. **Case of Dr. De la Pommerais.**—(See *Tardieu and Sonnenschein*, p. 209.)—Dr. De la Pommerais insured the life of a woman (Pauw), and then poisoned her with digitaline. (Page 19.)

40. **R. v. Cotton.**—(*Durham Lent Assizes*, 1873.)—Tried for the murder of her step-son by arsenic. She was said to have killed twenty persons, all of whose lives she had insured in different offices. Prisoner found guilty, and executed.—(See Taylor, p. 645.) (Page 19.)

41. **R. v. Palmer, 1856.**—(*Central Criminal Court, May*, 1856.)—Insurances effected by Palmer on the lives of persons that he afterward poisoned. (*Taylor*, vol. i., p. 405; vol. ii., p. 642, etc.) (Page 19.)

42. **Case related by Tardieu, Ann. d'Hyg., 1866, Vol. II., p. 410.**—Case of J. P. Hoffstedt.—This man was insured by another person (Swensson). Swensson was prosecuted by the office on the ground that he agreed to give deceased brandy *ad lib.*, provided he took no other nourishment. It was also suggested that Swensson had given Hoffstedt arsenic. Prisoner was acquitted from want of direct proof, but a verdict was given for the Office, because the case was regarded as one of suicide through the agency of a person who would benefit by the death. (Page 19.)

43. **Scotch Insurance Case.**—("*Taylor's Med. Juris.*," Vol. I., p. 672, and Vol. II., p. 640.)—Death caused from pistol shots. Certain circumstances pointed to a murder having been committed by a certain medical man, who had insured the man's life. Prisoner was acquitted, on the ground that there were no circumstances directly fixing the crime on him. It was shown that the prisoner could have no lawful pecuniary interest in the life of the man he insured. (Pages 12, 19.)

44. **Exors. of Fauntleroy v. The Amicable.**—(See *Bolland* v. *Disney*, 3 *Russell's Chancery Reports*, p. 351; 4 *Bligh, N. S.*, 194.)—Payment disputed, on the ground that Fauntleroy was hanged for forgery, and that his death was as much his own act as if he had committed suicide. The Master of the Rolls decided against the Company, "because the act must be done fraudulently, for the very purpose of procuring the event." This was reversed on appeal to the House of Lords, on the ground that if the policy had, in express words, attempted to insure against death at the hands of justice, it would have become void, as against public policy. (Page 18.)

45. **Kinnear v. the Rock Insurance Company.**—(5 *Man. and Gr.*, 644.)—Probable suicide of insured from narcotic poisoning. Verdict for plaintiff on the ground that the suicide was not proved. Coroner's jury found "Death from natural causes." (See *Taylor, loc. cit.*, vol. ii., pp. 634–638.) (Pages 13, 18.)

46. **Borrodaile v. Hunter and others.**—(5 *Man. and Gr.*, 639.)—

Suicide (?) of insurer, who was seen to go into the water, the question being was he sane or insane at the time. Judgment for plaintiff, but afterward reversed—the case being compromised. (Pages 18, 20.)

47. **Schwabe v. Clift.**—(5 *C. B.*, 437.)—Suicide from taking sulphuric acid. The question in dispute was whether the man at the time was sane or insane. Verdict for plaintiff (executors of insured). A new trial granted, but the case eventually compromised. (Page 20.)

48. **Case related by Tardieu, occurring in French Courts.**—(*Ann. d'Hyg.* 1860, 1,443.)—The insured died from the explosion of a gun in his carriage as he was driving. Question—Was it accident or suicide? Tardieu believed it suicide from the position of the gun and body and the direction of the wound. Verdict for the plaintiffs (executors of insured). The Company, it was decided, were bound to prove their case by more than mere presumptive evidence, and this the Court held they had not done. (Pages 13, 18, 19.)

49. **Beake v. Nicholson and Others.**—(Mutual Life Insurance Company.)—Claim, £1,000. Disputed on the ground that the insured died by his own hands. The widow contended that he was under an insane delusion, not knowing what he was doing or the consequences of his act. [The deceased had thrown himself under an engine in motion at Battersea Station.] Verdict for plaintiff. Rule *nisi* for a new trial obtained, and afterward rule made absolute. (Page 19.)

50. **Case reported by M. Brierre de Boismont.**—(*Ann. d'Hyg.*, 1866, 2, 397. *A French case.*)—Claim, 40,000 francs. Payment disputed on the ground that the man had committed suicide by hanging. This was proved by a letter of the deceased, in which he stated he had done it to preserve his family from ruin by obtaining the insurance money. Judgment for the Company. In this case a friend had agreed to cut the body down after the insured had hanged himself and place it in the high road, so as to present the appearance of the insured having been murdered. (Page 18.)

51. **Sinclair v. the Maritime (Accident) Insurance Company.**—(30 *L. J., Q. B.*, 77.)—Life of a Capt. Lawrence.—Payment disputed on the ground that "sunstroke" was not an accident. Verdict for the defendants on the ground that "sunstroke was a natural cause of death." (Page 11.)

52. **Cross v. the Railway Accident Insurance Company.**—(*Lewes Summer Assizes*, 1871.)—Payment disputed on the ground that,

although the insured fell downstairs and was never well again, she died from disease and not from accident. Verdict for defendants, except £30 paid into Court. Medical evidence conflicting. It was deposed that she had Bright's disease and dropsy. (Page 10.)

53. **Mair v. Railway Passengers' Insurance Company.**—Before Mr. J. Denman. See "*Daily Telegraph,*" April 19, 1877.—(37 *L. J.*, 356.)—The man received a push in a street brawl, and pitched on his head on the granite pavement, receiving injuries that terminated fatally. The Company stated he was very intoxicated at the time. Verdict for plaintiff. A rule obtained for a new trial, in which it was laid down:—In a policy of life assurance it is provided that the assurance shall not extend to any death or injury happening while the assured is under the influence of intoxicating liquors or occasioned by his wilfully exposing himself to any unnecessary danger or peril. Although in this case there was a conflict of evidence as to the fact of the assured being affected by the liquor he had taken, nevertheless it was proved that he had accosted a woman in the street, and persisted in doing so in the face of remonstrances, and was finally knocked down by the man in whose company she was at the time, receiving injuries from which he died. It was held that to enable the Company to take advantage of the above proviso it was not necessary that the assured should be under the influence of intoxicating liquor at the time of his death as well as at the time when the injury was sustained, but that it was sufficient to show that he was under such influence when he met with the injury from which death afterward resulted. "Under the influence of intoxicating liquors" means under such influence as to disturb the quiet exercise of a man's intellectual faculties. (Pages 10, 11.)

54. **Fitton v. Accidental Death Assurance Company.**—(17 *C. B., N. S.*, 122.)—An insurance against accident, provided the accident operated by external causes, was in this case held to cover an injury to the spine caused by lifting a heavy weight in the course of business. (Pages 10, 11.)

55. **Martin v. Travellers' Insurance Company.**—(1 *F. and F.*, 505.)—An insurance against accident contained an express clause excepting "death arising from gout, hernia, or other disease arising within the system." In this case the insured had a fall, which proved the primary cause of rupture and strangulated hernia, after an operation for which the assured died. It was held that his representatives were entitled to recover, and that the case did not come within the exception. (Page 10.)

56. **Winspear v. the Accident Insurance Company, Limited.**—(*L. R.*, 6 *Q. B. D.*, 42.)—W. effected an insurance with the defendants

against accidental injury, and by the terms of the policy the defendants agreed to pay the amount to W.'s legal representatives should he sustain "any personal injury caused by accidental, external, and visible means," the direct effect of such injury being to cause death. The policy also contained a proviso that the insurance should not extend "to any injury caused by or arising from natural disease, or weakness or exhaustion consequent upon disease." During the time the policy was in force, and whilst the assured was crossing a stream, he was taken with an epileptic fit and fell into it, and was there drowned whilst suffering from the fit; but he did not sustain any personal injury to occasion death other than drowning. Held that W.'s death was occasioned by an injury within the risk covered by the policy, and to which the proviso did not apply. The reasons given in the Court of Appeal were, that the drowning was the cause of death, and the fit was only a cause of the cause of death.—(Trew v. Railway Passengers' Assurance Company, 30 *L. J.*, *Eq.*, 317. 22 *L. T.*, *N. S.*, 820, Reynolds v. Accident Assurance Company.) (Pages 10, 11.)

57. **Smith v. Accident Insurance Company.**—(*L. R.*, 5 *Ex.*, 302.) —A policy of insurance against death from accidental injury contained a condition that it was not to insure against death arising from rheumatism, gout, hernia, erysipelas, or any other disease or secondary cause arising within the system of the insured before or at the time of or following such accidental injury (whether causing such death directly or jointly with such accidental injury). The assured on Saturday, April 24th, accidentally cut his foot against the broken side of an earthenware pan. On the Thursday following, erysipelas supervened, and he died of that disease on the next Saturday. The erysipelas was caused by the wound, and but for the wound he would not have suffered from erysipelas. In an action by his executrix to recover the amount insured, it was held (Kelly, C. B., dissenting) that the insurers were protected by the above condition and were not liable. (Pages 10, 12.)

58. **Duckett v. Williams.**—(2 *C. and M.*, 348.)—By a declaration and statement as to health signed by the assured previously to effecting a policy on a life, it was agreed that if any untrue averment was contained therein, or if the facts required to be set forth in the proposal (annexed) were not truly stated, the premiums should be forfeited, and the assurance be absolutely null and void. The statement as to the health of the life was untrue in point of fact, but not to the knowledge of the party making it. Held that the premiums were forfeited and could not be recovered. (Page 15.)

59. **Macdonald v. Law Union Fire and Life Insurance Company.**—(*L. R.*, 9 *Q. B.*, 328.)—A policy of insurance was granted by a

company to the plaintiff on the life of T., containing a proviso that "if the declaration under the hands of the plaintiff delivered at the company's office as the basis of the insurance is not true in every respect, and if there has been any misrepresentation . . . then the insurance shall be void." Held that an inaccurate statement of a material fact contained in the declaration rendered the policy void, though the statement was made bona-fide, and was not untrue to the knowledge of the plaintiff. (Page 15.)

60. **Watson v. England.**—(8 *Jur.*, 1062.)—M. B., then about sixteen years of age, and unmarried, left her father's house in the year 1814, and was never heard of afterward as being alive. About the year 1839, however, her father told Deponent that he had intelligence by a man who came from London, that his daughter, M. B., was dead. The Master found that she was dead, but that sufficient evidence had not been laid before him to enable him to find when she died, or whether she died unmarried and without issue. An exception that the Master ought to have found that she died previous to the end of the year 1821 was overruled. An exception that the Master ought to have certified that M. B. had died unmarried and without issue allowed. (Page 23.)

61. **Church v. Smith.**—(*Exchequer*, Dec., 1853.)—Fourteen years previously to the case coming before the Court, the husband deserted his wife, and she had not heard of him for twelve years. *Question:* Was she a widow, and able to sue in her own right?

She was nonsuited, however, by the husband appearing in the witness-box at the trial.

(The Chief Baron remarked, that but for this he should have directed the jury, if it had been proved that he had not been heard of for twelve years, to consider him dead.) (Page 23.)

62. **R. v. Briggs.**—(*D. and B., C. C.* 98, 1856.)—The prisoner was indicted for bigamy, the first marriage being with J. Briggs, in 1844, at Altonbury, and the second in 1856, at Cambridge. The prisoner on both occasions was married by her maiden name, and the second husband swore that she had represented herself to him as a single woman. Altonbury and Cambridge are about twenty-four miles apart. J. Briggs was a laboring man, considerably older than the prisoner, living in lodgings, and working at a farm about two miles from Altonbury, being occasionally absent from home for a month at a time. A witness said that the prisoner left him four months after the marriage, and that he had not seen her subsequently. The jury were asked whether, in their opinion, the prisoner knew her husband to be alive at the time she contracted the second marriage, and if not, whether she had the means of acquiring the knowledge.

They were directed that, even if they thought her ignorant of her husband's being alive, she must still be found guilty if they also thought she had neglected to exercise such reasonable diligence in making inquiry as might have ascertained the fact of his existence. The jury said they had no evidence as to her knowledge; but that in their opinion she had the means of acquiring knowledge, if she had chosen to make use of them. Upon a case reserved after a verdict of guilty, it was held that the conviction was wrong, the verdict being imperfect, as the jury had not found that the prisoner knew her husband was alive. (Page 23.)

63. **R. v. Lumley.**—(38 *L. J., M. C.*, 86.)—The prisoner was convicted of bigamy. The first marriage was with Victor in the year 1836. The second marriage was with Lumley on the 9th of July, 1847. The prisoner lived with Victor until the middle of 1843, when they separated, and from that time no more was heard of him. There was no evidence as to his age. The judge at the trial directed the jury that it was a presumption of law that Victor was alive at the time of the second marriage. Held that there was no presumption of law that life continued for seven years, or for any other period after the time of the latest proof of the life of the party, and that it was a question of fact for the jury, under the circumstances of each case, whether a person be alive or dead at any time within the interval of seven years, at the termination of which the protection afforded by the statute in cases of bigamy comes into operation. The conviction was quashed. (Page 23.)

64. **Doe v. Nepeun.**—(5 *B. and Ad.*, 86, 1833.)—A person who has not been heard of for seven years is presumed to be dead, but there is no legal presumption as to the time of his death. The fact of his having been alive or dead at any particular period during the seven years must be proved by the party relying on it. (Page 23.)

65. **In re Phene's Trusts.**—(*L. R.*, 5 *Ch.*, 346.)—If a person has not been heard of for seven years there is a presumption of law that he is dead, but at what time within that period he died is not a matter of presumption but of evidence, and the onus of proving that the death took place at any particular time within the seven years lies upon the person who claims a right to the establishment of which that fact is essential. There is no presumption of law in favor of the continuance of life, though an inference of fact may legitimately be drawn that a person alive and in health on a particular day was alive a short time afterward. The testator died on the 5th January, 1861, having bequeathed his residuary estate equally among his nephews and nieces. One of his nephews, N., was born in 1829, had gone to America in 1853, had frequently written home until August, 1858, on which date he wrote from on board an American ship of war. From

that time no letter had been received from him, and nothing was afterward heard about him, except that he was entered in the books of the American Navy as having deserted on 16th June, 1860, while on leave. Held (reversing the decision of James, V.C.,) that his personal representative had not established a title to any share of the testator's estate, and it must be divided among the nephews and nieces who were proved to have survived the testator. (Page 23.)

66. **In re Beasney's Trusts.**—(7 *L. R. Eq.*, 498, 1869.)—A person who was entitled to the dividends on stock payable in April and October, applied for his dividends in April, 1860. He was last seen in August of the same year, when he was in a very bad state of health. He never applied for his half-yearly dividends in the ensuing October. It appeared that he was of very dissolute habits, and chiefly depended on the dividends for his maintenance. The question in this case was whether he died before November, 1860. Held that not having applied for the dividends due to him in October, 1860, and having regard to the state of his health when last seen, the presumption must be that he died before November, 1860. (Pages 23, 24.)

67. **Prudential Assurance Company v. Edmonds.**—(*L. R.*, 2 *App. C.*, 487.)—A policy on the life of R. Nutt was granted in 1863. An action was brought in 1874, the question being whether Nutt was then alive or dead. He had been absent from his former home more than seven years, having left it in 1867. His sister and brother-in-law, who lived where he had formerly lived, gave evidence of his absence, and said that they had not heard of him for more than seven years. On cross-examination, they admitted that a niece of his had said that when she was in Melbourne in December, 1872, or January, 1873, she saw a man whom she believed to be her uncle Nutt, but he was lost in the passing crowd before she was able to get to speak to him. No effort appeared to have been made to find him at Melbourne, and the other relatives believed the niece to have been mistaken. The jurymen expressed a similar opinion. The Judge directed the jurymen that they "could not say that the man had not been heard of during the last seven years, when one of his relatives declared that she had seen him alive and well within the last three years; and still less could they say that he had never been heard of when all the members of the family stated that they had heard what she had stated;" and "that the ground for the presumption of death from a man having been absent for seven years, was entirely removed by the direct evidence that every relative had heard that he was alive." And, lastly, his Lordship said to the jury, "under these circumstances, unless you are prepared to find that he was dead in April, 1875, and find it upon evidence which tends to prove exactly the contrary, and in the absence of that evidence

upon which alone the presumption should be raised of his death, your verdict ought to be for the defendants." The Court of Appeal considered this to be a misdirection, and had ordered a *venire de novo*. On appeal to the House of Lords, the Lords were equally divided, and so the decision of the Court of Appeal stood. Per Lord Blackburn :—When there is a case tried before a Judge sitting with a jury, and there arises any question of law mixed up with the facts, the duty of the Judge is to give a direction upon the law to the jury so far as to make them understand the bearing of the law upon the facts. Further than that it is not necessary to go. (Pages 13, 23, 24.)

68. **Re Davy.**—(*Probate Court*, 1858.)—The testator (a master mariner) sailed for Melbourne in December, 1856. He was proved to have arrived at Calcutta in October, 1857, and to have left Calcutta for Port Louis in December, 1857. From that date nothing was heard either of the testator or of the vessel. Probate of the will granted although not more than two years had elapsed since the testator's departure from England. (Page 24.)

69. **Macleane v. Insurance Company.**—Macleane insured his life. On November 28th, 1777, he sailed from the Cape in a small sloop, and was never heard of afterward. There was evidence to show that several vessels which sailed at or about the same time, and which were of a stronger build than Macleane's, were lost in a storm that occurred in January, 1778. A verdict was given for the plaintiff. (Page 24.)

70. **Re Vital Douat.**—In this case a man shortly before his bankruptcy insured his life in an Insurance Company of Paris for 100,000 francs. His bankruptcy was subsequently declared fraudulent. He then came to England, purchased a coffin, procured a certificate of death from the registrar, himself followed the coffin (which he had loaded with lead) to the grave in a churchyard in Essex, where it was interred. This done, his wife then went to Paris and presented to the Company copies of the registry of the death and the burial of her husband, and claimed the amount of the insurance. The coffin was exhumed, the man was taken into custody at Antwerp, and given in charge to the French authorities. [A register of death is no absolute proof of death !] (Page 24.)

71. **R. v. Dr. Hay.**—(*Beck*, p. 361.)—In 1766, General Stanwix and daughter set sail in the same vessel from Ireland for England. They were shipwrecked, and not a single person on board was saved. The representative to the personal estate of the father was the nephew, and the representative of the daughter was her maternal uncle. These parties brought the case into Chancery. On behalf of the nephew whom the general's

survivorship would benefit, it was argued, that the ship being lost in tempestuous weather, it was more than probable that the general was upon deck, and that the daughter was in the cabin, and subject to more early loss of life than the general, who, as a man of arms and courage, was, it was asserted, more able and more likely to struggle with death than a woman. Further, it was argued that he might probably have been assisted in his struggles by the broken masts and other parts of the rigging.

On the other side it was contended that the general was old, and consequently feeble, and by no means strong enough to resist the shock of such a terrible attack, whilst the daughter was of a hale constitution, and being younger than her father, was proportionately stronger. It was contended therefore that the probability of survivorship was infinitely in favor of the daughter.

A second wife of General Stanwix also perished with him, and her representative brought forward a separate claim to the disputed property.

The Court, however, finding the arguments on all sides to be equally solid and ingenious, waved giving any decision, and advised a compromise, to which the several claimants agreed. (Page 30.)

72. **Taylor, Vol. i., p. 169.**—Three persons, consisting of a woman aged forty-two in feeble health, a stout healthy daughter of twenty, and a son aged six, were drowned off the coast of Norfolk. It was contended that the probabilities were that the daughter, aged twenty, survived; but Dr. Lushington, in the absence of proof, ruled that they all perished together.

Dr. Taylor gives the following detailed account of this case :—"An officer in the army died in November, 1819, leaving a wife and two daughters, bequeathing property among them. In 1823 the widow married again, and by this second marriage she had several children: one of these, a son, survived. One of the daughters by the first marriage, Margaret, died in 1825, before majority, intestate, leaving only as next of kin her sister Johanna and her mother. In 1834 the mother, her daughter Johanna, and her son, the last surviving child of the marriage between her and her second husband, were drowned on the coast of Norfolk, in the cabin of a sailing-packet, while on their way to Scotland. The vessel filled with water from the skylights of the cabin during a storm. A few minutes before the catastrophe, all in the cabin were seen and spoken to, but not one of them was heard to speak or was seen alive after the cabin had become filled with water, which was said to have happened instantaneously. The deaths of the mother, daughter, and son, were supposed to have taken place at one and the same instant of time; at least it could not be proved by the direct testimony of any person that he saw any one of the three alive, or that he heard the cry or speech of any one of these three after the death of the other or either of them. It may be mentioned that the mother was cor-

pulent, and by the ill-treatment of her husband a broken-hearted woman of about forty-two years of age ; the daughter was a stout healthy girl of about twenty, and the son about six years of age. Physical and constitutional strength were thus decidedly in favor of the survivorship of the daughter Johanna, who was in right of considerable funds at the time of her death and she died intestate. A claim was made for her property by her nearest blood-relation, her paternal uncle-german. Her mother's second husband being still alive, claimed the property, as the representative of his wife or his son, presuming that Johanna died before them, and that her property became vested in them. The opinion of Dr. Lushington being requested on this case, he stated that as to the question of survivorship, the presumption of law, in the absence of evidence to the contrary, was that the mother, daughter, and son all died at the same moment. The consequence would be that none of the parties could transmit to the other. The paternal uncle would therefore be entitled to Johanna's property on the principle already applied in so many cases, that the property being vested in her, those who desire to take it on a presumption, must produce evidence to show that she died before those persons through whom they set up a claim.

"In this case there was not the least ground, medically speaking, for assuming that either of these persons survived the other. There was no evidence as to whether they were in different parts of the cabin, or whether the water reached one before the other ; and in the absence of all facts of this kind, it would be an arbitrary assumption to assign survivorship to one." (Page 30.)

73. **Underwood v. Wing.**—(4 *De G., M. and G.*, 633.)—A testator by his will bequeathed personal estate to J. W. upon trust for his (the testator's) wife absolutely, but in case his said wife should die during his lifetime he directed that all his estate should be held by his said trustee upon certain trusts (which failed), and subject to those trusts he bequeathed all his property to J. W. absolutely. Held—that the gift to J. W. was dependent on the event of the testator surviving his wife, and that J. W. did not become entitled from the mere fact of the gift to the wife failing to have practical operation. The testator and his wife were shipwrecked and drowned at sea, one wave sweeping both of them together into the water, after which they were never seen again. On the question being raised between the next of kin of the testator and J. W., who claimed under the limitations of the will, it was held—first, that the onus of proof that the husband was the survivor rested with J. W. ; secondly, that it was requisite to produce positive evidence in order to enable the Court to pronounce in favor of the survivorship ; and thirdly, that no such evidence having been produced, the next of kin was entitled. [By the law of England the question of survivorship, in cases of the above description, is mat-

ter of evidence, and not of positive regulation and enactment as in the French code, and in the absence of evidence there is no conclusion of law on the subject. The next of kin stands as to personalty in the same position as the heir at law as to realty, and the person claiming against him must make out his title.] (Pages 24, 29, 30.)

74. **Taylor and Others v. Deplock.**—Case in Prerogative Court, Doctors' Commons, 1815:—

Job Taylor, quarter-master sergeant in the Royal Artillery, had made a will, in which he appointed his wife, Lucy Taylor, sole executrix and sole residuary legatee. Having been for some time in Portugal on foreign service, he was returning home with her on board the Queen transport, when the vessel, in Falmouth Harbor, struck upon a rock, in consequence of the violence of the weather, and sunk almost immediately afterward. Nearly three hundred persons on board perished, and among them Taylor and his wife. Taylor died possessed of property to the amount of £4,000, and a bill in Chancery was filed by the next of kin of the wife against those of the husband, to ascertain who was entitled to this property, but the proceedings were at a stand for the want of a personal representative of the husband. Both parties, therefore, applied to the Court for letters of administration generally, or that the Court would suspend granting any to either party during the dependence of the Chancery suit, and in the meantime grant a limited administration. This latter prayer was, however, abandoned, on understanding that the Court could not grant a limited administration where a general one might be granted and was applied for; and the present question, therefore, was to whom the general administration should be granted—whether the next of kin to the husband as dying intestate, his wife not having survived so as to become entitled under his will, or the representatives of his wife, as his residuary legatee, she having survived so as to become entitled under that character.

It appeared from the affidavits exhibited on both sides, that at the time the accident happened, Lucy Taylor was below in the cabin, and her husband on deck. The water was rushing in fast, and he offered large sums to any one who would go below and save her, but finding none would venture, he descended himself, and the vessel immediately afterward went to pieces. The bodies of Taylor and his wife were found close together, and it further appeared that she was a woman of a very robust constitution, and in the habit of enduring great fatigue by the management of the officers' mess, as well as that of a great many of the soldiers; whilst he was rather sickly, and had been latterly much afflicted with an asthma.

It was contended on the part of the husband's next of kin, that by the principles of the Roman civil law, which had been adopted into the law of the country, and were in fact the only principles governing a case of this kind, it was laid down, that where two persons perished together in a com-

mon calamity, and it became a question which of the two was the survivor, the presumption of law should always be in favor of the person possessing the more robust constitution and greater strength, as being thereby the better fitted to struggle with the difficulties of his situation and resist for a longer time the operation of death. Thus, when the father and son shall perish together, the presumption of the survivorship is in the favor of the son if above the age of puberty, but of the father if under: the same as to a mother and daughter; and as to husband and wife, the presumption is in favor of the husband. This, however, like all other legal presumptions, was liable to be repelled by evidence to the contrary, but in this case it was contended, from the situation of the wife at the time the accident happened, that it was most probable she had perished before her husband descended to her rescue. Upon both grounds, therefore, both of principle and of fact, the Court must conclude that the husband was the survivor, and accordingly grant the administration to his next of kin.

On the part of the wife's next of kin it was contended that the presumption of the law alluded to was only applicable to cases where parties perish together in such a manner as to preclude the possibility of obtaining any evidence as to which of them was the survivor. Where, however, evidence as to that fact was produced, as in the present case, the case must be decided upon that evidence only. Here it appeared the parties had perished by the same accident, and their bodies were afterward found together; and that the common course of nature had in this instance been inverted, by the wife being the most strong and robust of the two. The Court must, therefore, necessarily conclude that she was the survivor, and accordingly grant the administration of her husband's effects to her representatives.

Sir John Nicoll observed that this case presented itself for decision under very singular circumstances. He recapitulated them, and observed that the question as to the limited administration had not been gone into; but that with respect to general administration, the counsel had argued upon the legal presumption of survivorship, and whether or not that presumption was sufficiently repelled by the facts in evidence. He agreed to the doctrine that had been laid down, of the presumption being in favor of the husband; but it was a necessary preliminary question upon whom the burden of proof rested. The administration to the husband being the point in issue, his next of kin had *primâ facie* the first right to it; but there being a residuary legatee, this right became superseded. The parties claiming under this latter character were not residuary legatees themselves specifically, but merely derivatively from one who was. They were, therefore, one step further removed from the property. The presumption of law was certainly always in favor of the heir at law with regard to freehold, and equally so of the next of kin with regard to personal property;

the statute of distribution disposing of an intestate's property among his next relatives solely upon the presumption that such was his intention, unless the contrary should be expressed. It was, therefore, incumbent upon the representatives of the wife, in this case, to prove her survivorship, as the party in whom the property vested, and from whom in consequence they derived their claim to it. He then entered into an explanation of the facts in evidence, and was of opinion that they were insufficient to repel the presumption of the husband's having survived the wife, which the Court was bound to assume, from the circumstance of their having been overwhelmed by one common calamity, and having perished together; observing in particular that though the wife might be very active and laborious in her domestic duties, yet the natural timidity of her sex might prevent exertion in the moment of danger; whilst the husband, on the other hand, though laboring under the bodily affliction of an asthma, might still retain his manly firmness in resisting impending destruction, particularly as, from his situation in life, he must have often faced death in various shapes. He was, therefore, in no degree satisfied by the proofs in the cause that the wife survived tho husband, and should, therefore decree the administration to his next of kin. In thus deciding the law, however, he did not mean to affirm positively which of the two was the survivor, but merely that there was not sufficient proof that it was the wife to repel the presumption of law that it was the husband. The administration was accordingly granted to the husband's next of kin. (Pages 29, 30.)

75. **Re Selwyn.**—(3 *Hagg*, 749. *Prerogative Court*, 1831.)—Mr. Selwyn, of the War-office, with his lady, perished in the disastrous accident to the "Rothsay Castle" steamboat (1831). By his will he appointed Mrs. Selwyn his executrix, but in case she should die during his lifetime other executors were appointed. The circumstances of their death raised the question whether the contingency provided for in the will had occurred, and whether the wife's representatives or the executors named in the event of her prior death, were to take administration.

The case came before the English Prerogative Court, November 7, 1831. The Court said that in other similar cases it had been held, as both parties might be supposed to have perished together, that the wife could not have survived the husband; but in this case the words were "in case she should die in my lifetime." The presumption was that the husband, as the strongest of the two, survived the longest; and as it was the clear intention of the testator that the representatives of the wife should not take the administration, and as there was no attempt on the part of those representatives to establish an intestacy, the Court decreed probate to the executors. (Pages 29, 30.)

76. **American Journal of Med. Sciences, July, 1845.**—On June 14th, 1838, Hugh Swinton Ball, his wife, and adopted daughter, were lost on board the steamer "Pulaski," off the coast of America. An explosion took place at 11 P.M., the husband and wife being in different parts of the vessel. Mr. Ball *was not seen after* the explosion, although the exact time of his death was not known. Mrs. Ball *was seen afterward,* rushing about frantically, and calling for her husband. She was soon missed, however, the deck where she was going under water. All were lost.

By will Mr. Ball had left his property to his wife, and her heirs now claimed it on the ground that she survived her husband.

The defendants argued that as the time of the wife's death could be fixed, whilst that of the husband's could not, it was fair to presume she died first.

Chancellor Johnson decided for the plaintiffs (viz., that Mrs. Ball survived her husband). He admitted the onus was on the plaintiffs to prove that she survived, but he considered the fact that Mr. Ball did not appear after the explosion, whilst his wife was seen and recognized, was sufficient.

On appeal this decision was confirmed. (Pages 29, 34.)

77. **Ommaney v. Stillwell.**—(23 *Bevan,* 328.)—(*Rolls Court,* 1856.)—This case arose out of the Franklin Expedition of 1845.

The question was,—Did James Couch or his son Edward die first?

The father died in January, 1850.

The son was mate (one of 133 persons of the expedition) on Franklin's ship "Erebus," which left England in 1845. Dr. Rae gave evidence that he was informed, in 1854, by certain Esquimaux, that in 1850 they saw a party of about thirty men pulling at a boat, one man (probably Sir John Franklin) acting as leader. The exact time was fixed as May, because they were seen to kill some birds that never visited the region before May. There was nothing, however, to show that Edward Couch was one of this party seen in 1850.

To avoid further litigation, however, and as one of the chief clerks had decided in favor of the son as survivor, the Court confirmed the chief clerk's report. (Page 34.)

78. **Case before Scotch Court of Session, 1857.**—Adam Fairholme, who died in May, 1853, left his property to his nephew, James Walter Fairholme, R.N., who went out as Lieutenant on board the "Erebus," in Franklin's Expedition (May, 1845). George Fairholme, another nephew, had instituted an action to have it found, under the destination of a codicil, that he was entitled to the whole of the testator's personal estate, valued at £37,509. This was opposed by other relatives, whose interests depended on whether or not James Walter survived his

father. Proof by commission was taken with the view of legally establishing the question raised in the case, and among those examined were Dr. Rae, Sir John Richardson, James Hargreave (chief factor in the service of the Hudson's Bay Company), Captain Penney and others. Dr. Rae expressed his belief that those persons who were reported to have been seen in the spring of 1850, must have died in the May of that year, and these he believed to have been the last survivors of Franklin's party. James Hargreave thought that some of the party might have survived a single winter after they had been seen by the Esquimaux in 1850, but certainly not longer. Sir John Richardson said: "That if any of the party reached the country where they were said to have been seen at the end of the winter of 1849–50, it was impossible for them to survive a single year with any means they could have at their disposal." Captain Penney remarked: "I do not think that any of the party could have survived 1852; they must either have perished from hunger, or the hostile attacks of the natives." The Lord Ordinary (Mackenzie) reported the whole circumstances of the case to the Inner House, expressing his own opinion that there was thus strong presumptive evidence that Lieutenant Fairholme perished; together with his companions, some time prior to the end of 1852, and consequently that he pre-deceased his uncle, the testator, who died in May, 1853. His lordship thought that, under these circumstances, the pursuer, George Fairholme, was entitled to a decree in his favor, but qualified by this condition, that before payment, he should grant a bond with sufficient security to warrant the defender against all hazard from any claim to the money decerned for by Lieutenant Fairholme or others in his right. (Page 34.)

79. **Green v. Green.**—(*Vice-Chancellor's Court, July,* 1861.)—Testator died in August, 1838, leaving by his will (dated April, 1838) £30 a year to his son James Green, and on his death the sum of £750 to his children, or if he had no issue to his brothers and sisters living at the time of James Green's death. James Green went to New South Wales in September, 1840. On February 1st, 1843, he wrote and acknowledged the receipt of his £30. So far as was known he died without issue. One of his brothers, Edward Green, died January 25th, 1846. The question before the Court was—Is it to be presumed that James Green died before or after his brother Edward Green? If before, Edward Green's children would be entitled to a share of the £750; but if after, they would not be so entitled.

The Vice-Chancellor ruled that the burden of proof lay on the plaintiff, who alleged that James was alive when his brother Edward died. The Vice-Chancellor decided that it must be presumed, seeing that nothing was heard of James after February 1st, 1843, that he died before Edward (January 25th, 1846). (Pages 24, 34.)

80. **Greetham v. Milnes.**—(*Rolls Court,* 1871.)—A question arose in reference to the survivorship of one Hentig, who was a member of Dr. Leichhardt's exploring party in Australia. The party left Sydney for the interior in February, 1848, with the intention of traversing the continent, and were not afterward heard of. The testator died in February, 1850, having bequeathed property to Hentig, who was his nephew. The heir at law of the testator claimed the property on the ground that Hentig died before the testator, who did not die until two years after Hentig was last seen and known to be alive. The heir at law of Hentig rested his claim on the absence of any proof of death at any time, and that the members of the expedition, including Hentig, might have survived at least two years in Central Australia. The Master of the Rolls said that the inference he must draw from the established facts was that Hentig died within a year of the exploring party leaving Sydney, and that the heir at law of the testator was therefore entitled to the property. (Page 24.)

81. **In re Lewis's Trusts.**—(40 *L. J., Ch.,* 602; *L. R.,* 6 *Ch. App.,* 356.)—[The death of a legatee is presumed after he has not been heard of for seven years, and there is no presumption of law that he lived beyond the first day of the seven years; but the onus of proving that he survived a given day lies on those who claim under him.]

In this case the question was whether a legatee did or did not survive a testator so as to take a sum of £4,000 bequeathed to him under the will, dated 1858. The testator died on February 20, 1860. The legatee, Thomas Lewis, went to Australia in the year 1858, and the last that was heard of him was by a letter written to a cousin dated January 3, 1859. Seven years having elapsed he was presumed to be dead, but the question was whether he survived his father. The Vice-Chancellor said that the law in cases of this kind presumed the continuance of life until the expiration of seven years, when the contrary presumption of death arose. The case of "Phene's trust" (p. 406) (39 *L. J., Ch.,* 316) had, however, displaced that rule, and had laid down that in all cases it was incumbent on a person claiming property by reason of a person being alive at any particular time to establish affirmatively that fact. It was manifest, therefore, that the representatives of the legatee, in order to claim their legacy, must show that the legatee survived the testator—the onus probandi being, according to the case cited, thrown upon them. They had not discharged, and could not discharge, that onus; therefore, as he was bound by the case in the Court of Appeal, he must hold that the legacy was never validly given, and that the residuary legatee took the fund as part of the estate. (Page 23.)

82. **Huelin v. Wilson.**—(*Vice-Chancellor Malins, July,* 1871.)—The question was whether the deceased Huelin survived his housekeeper or not. He had made a bequest in favor of this woman. In May, 1870, Huelin and

his housekeeper were found dead in a house at Brompton. They had obviously been murdered. The body of Huelin was found buried, while that of the woman was packed in a box, and had marks about it of more recent death. The medical and circumstantial evidence left no doubt that the murder of the woman had not taken place until after the death of Huelin the testator, and the Vice-Chancellor decided accordingly that she survived to take the bequest. (Pages 29, 31.)

83. **Broughton v. Randall.**—(*See Med. Jur., J. A. Paris, M.D.*, p. 390. *Crokes, Elizabeth*, 502.)—A father and son, both of whom were hanged at the same time, were seized as joint tenants and to the heirs of the son. The son was held to have struggled the longest and therefore to have survived the father, the evidence being that a certain shaking of his legs and other signs of life were noticed in his case. The wife of the son on this evidence was held entitled to her dower. (Page 25.)

84. **British and Foreign Med. Chir. Review, p. 189.**—A large sugar-warehouse, situated in Alston Street, was suddenly destroyed as follows: A rise was expected in the price of sugar, and the firm to whom the establishment belonged, thinking to profit thereby, bought up and incautiously stowed on the second floor of the building innumerable large hogsheads of the said material. The floor thus immoderately strained, gave way, and in so doing pushed out the sides of the building, causing its utter demolition. The men who were employed on the premises at the time were of course involved, and it was found on removing the rubbish, with a view to saving such as still survived, that death, as a rule, prevailed in proportion as the *débris* was cleared away—in other words, those who had been at the top of the building, and who consequently were supplied with a certain amount of fresh air, escaped with more or less severe injuries; while those employed in the second and ground floors were, with a few exceptions, found dead. The subject of one of the exceptions, according to his own account, had been struck down by a falling beam, which resting at an angle above him, at once protected him from descending splinters and the deplorable effects of suffocation. (Pages 31, 32.)

85. **Beck's Med. Juris., pp. 211, 213.**—A number of individuals perished by the fall of a building, and among them a father aged sixty, and his son aged thirty. The bodies were found ten hours after the accident. That of the father was uninjured, but on the head of the son there was a severe wound. The heirs of each put forth their claims, and Zacchias was consulted on the case. After a long comparison between the strength and state of health of the parties, he came to the conclusion that the son survived the father. Being aware, however, that the wound in

question was supposed to have accelerated the death of the son, he endeavors to avoid the difficulty by suggesting that it was not necessarily mortal, nor of a nature to destroy his strength immediately; while the suffocation was so much the more urgent cause of death, that the father, from his valetudinarian state and his advanced age, would be first destroyed by it. (Pages 28, 31, 32.)

86. **Medical Times and Gazette, July 15, 1876.**—(*Before Vice-Chancellor Malins.*)—A solicitor died intestate in 1869, but possessed of large property. He had three children—an elder son, a daughter, and a younger son. His son was last seen in 1868, having been sent away from his father's house. At the father's death advertisements were issued for him unsuccessfully. The daughter married, and died before the case was heard, her son bringing the action. When this daughter married she made a settlement that affected any money that came to her by her elder brother's death. Hence the real question at issue was—Was the brother alive when she died? because, if so, she could not deal with money over which she had no control.

(1.) Did the son die before the father? because, if he did, he could have no share in the property, and it would be divided between the two survivors. The Vice-Chancellor decided that he must be considered alive in 1869.

(2.) Therefore, the son being alive, was the property still to be held in reserve for him, should he turn up? This was 1876. Seven years had elapsed since he was last heard of. Therefore the Vice-Chancellor decided his share in the estate might be disposed of.

(3.) But the sister was also dead. Did the brother or sister die first? If the *sister*, the elder brother's share would be divided amongst the next of kin; if the *brother*, then it would be subject to the marriage settlement. The period of the sister's death was known, but not the brother's. The executors could not prove the date of the brother's death (even if he was dead), and this they were bound to do. The Vice-Chancellor decided that the elder brother having inherited, and by law presumed to be dead, his inheritance must be divided amongst the next of kin (viz., his younger brother and his nephew, the plaintiff.) (Page 34.)

CHAPTER II.

HEAT AND COLD.

(Considered Medico-Legally.)

The Temperatures of Health and Disease.—The Tolerance of the Body for Extremes of Heat and Cold.—(A) The Effects of Extreme Cold.—Symptoms.—The Treatment of Persons Suffering from Exposure to Cold.—Post-Mortem Appearances.—(B) The Effects of Extreme Heat.—Thermic Fever.—Sunstroke.—Symptoms.—Treatment.—Post-Mortem Appearances.

(Illustrative Cases, page 82.)

Extremes of Temperature considered generally.

In health, the body has an average temperature in the mouth and axilla of 98.6° F. (37° C. or 29.6° R.), whilst in the rectum and vagina, the temperature usually is from 0.9° to 1.3° F. higher. The daily range (excursus) rarely exceeds 1.8° F. (= 1° C.) above or below the average stated. In other words, the axillary temperature may *fall* to about 97° F. (36.1° C.) without collapse, or *rise* to 100° F. (37.77° C.) without fever.[1]

Heat production in the body is admittedly a complex problem. At any rate all are agreed that the body temperature is of internal origin, external heat playing no other part than as an economizer of the heat generated within. And again, whatever other internal sources of heat there may be (such as muscular movements, capillary friction, etc.), the chief part results from tissue change, and the decomposition of nutritive substances.

Thus it would seem that the heat-regulating power of the human body suffices in health by the use of appropriate food, clothing (*British Med. Journ.*, 1874, II., p. 824), and other means, to preserve the temperature within a very narrow range—age, sex, condition in life, season

[1] Even in children, where the temperature is very mobile, these limits are rarely exceeded.

of year, climate, etc., apparently making little difference. (*Lancet*, March 13, 1880, p. 430.)

But in most diseases, and after accidents, the temperature usually rises or falls beyond the normal. On this fact the use of the clinical thermometer depends.

Thus the body temperature in cases of accident and in certain diseases may become very high, 108° F. being common in severe agues and in neuroses, whilst 115° F. has been attained in scarlet fever. Even a temperature of 122° F. is recorded by Mr. Teale, after injuries occasioned by a fall from a horse (Meeting of Clinical Society, Feb. 26th, 1875).

Or taking the opposite condition of very low temperatures, Dr. J. J. Reincke (*British and Foreign Medico-Chirurgical Review*, April, 1876) records the case of a man, æt. 34, picked up in a state of intoxication at midnight (the thermometer in the air registering 30° F.), whose temperature in the rectum at 8 A.M. was only 75° F. After two hours it rose to 77° F., and at 12 noon reached 82° F. Reaction then set in, when the temperature rose above the normal. He recovered perfectly. In another case of alcoholism recorded by Magnall, where a man was exposed to a cold and damp atmosphere, his temperature sank as low as 78.8° F. (26° C.)[1]

But these cases of very high and of very low temperatures are exceptional. The high temperatures of fevers are often tolerated, and terminate favorably, because there are remissions. Many consumptives live for months with a temperature greatly above the average, because at some hour of the day or night (if not every day, at least every other day), it falls either to the normal, or very near it. But as general laws the two following statements may be received:—

(1.) *If the temperature of a warm-blooded animal be raised by any means* 11° *to* 13° *F.* (= 6.1° *to* 7.20° *C.*) *above the normal for any length of time, death is inevitable.*[2]

Bernard's experiments show that even 7° to 9° F. *plus* the normal heat, if continued, kills most animals. In such cases cadaveric rigidity sets in rapidly, is strongly marked, and lasts a long time.

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[1] Very high, and sometimes very low, temperatures occur shortly before death. Very acute diseases, especially neuroses, such as tetanus, etc., and fevers (including cholera) are known to exhibit great heat just before and after death.

[2] See Richardson (*Med. Times and Gazette*, Jan. 9, 1869), Bernard, Chossat, De la Roche, Berger (*Experiences sur les Effets qu'une forte Chaleur produit sur l'Economie*, Paris, 1805; *Journal de Physique*, t. 63, 71, and 77).

(2.) *If a warm-blooded animal is kept in a cold so intense that its normal temperature is depressed for any length of time* 18° *to* 27° *F.* (= 10° *or* 15° *C.*), *death is inevitable.*

This was shown experimentally by Walther's experiments. In the case of rabbits, it has been found that they die immediately their temperature is reduced 16.2° F. (9° C.) below the normal. Artificial respiration may restore some which have not been quite so much cooled, but unless artificial respiration is used, it has been found that a long exposure to cold prevents their regaining warmth, even in a warm atmosphere. Some of the lower animals may no doubt be completely frozen, and yet recover; and stories of the resuscitation of frozen human beings are on record. On this point we may say, that we have no authentic case of recovery where the whole body has been frozen. No doubt parts of the body may be frozen without much harm resulting. Thus John Hunter and others showed that the ears of rabbits and the combs of cocks may be so frozen as to be rendered hard and brittle, and yet recover vitality with proper care.[1] Experience shows not only a wonderful *law of tolerance* as regards extremes of temperature borne by different nations, but also of tolerance in respect to individuals, *e.g.*, aëronauts, Arctic explorers, etc.

This subject may become important in relation to questions of survivorship. Thus it may be necessary to consider which sex, and whether the young, the middle-aged, or the old, bear extremes of heat and cold best. Our answer to this question, so far as experience and experiments allow us to formulate a reply, must be as follows:—

(*a.*) *The very young, and the very old, have limited powers of heat-production. They, therefore, bear extreme cold badly. Young adults bear cold best, whilst young males bear cold better than females of the same age.*

Ricord has shown that the mortality from cold is twice as great in those under 20 years of age, as in those between 20 and 40, but that after 40 the power of resisting cold diminishes to such an extent, that the danger to life is doubled for every additional nine years.—("*Lancet*," 1874, II., p. 844. See also Dr. Buchan's Paper in the "*Medical Times and Gazette*," 1879, I., 93; "*British Med. Journ.*," 1875, II., p. 791.) (See page 65.)

[1] See some experiments on toads, in the "London and Edinburgh Journal of Medical Science," Feb., 1843. For the effects of cold on cold-blooded animals, see a series of experiments by Doehnhoff, recorded in the *London Medical Record*, 1873, p. 387; also Experiments by Prof. Horvath, of *Kiew, British Med. Journ.*, 1873, I., p. 204.

(*b*.) *The young are said to bear extreme heat better than the middle-aged or the old.*

Beck states this on the authority of Burckhardt, but it requires, in our opinion, further confirmation. Many of the victims of sunstroke are young people, and one of the earliest recorded cases was that of a child (2 *Kings* iv. 18).

From the facts we have noted—(1) of the narrow range of health temperatures, and (2) of the well-marked alterations of temperature in certain diseases—it follows that few things are more trying to the body even in health, than rapid changes of temperature. Men live and thrive, it is true, both in the Tropics and in the extreme North and South; but those seasons and places in which there is a great diversity of temperature during the 24 hours, are deemed unhealthy. The one circumstance in which the various "health resorts" agree (and they agree in nothing else, for some are very warm, and others very cold), is that the daily fluctuations of temperature are comparatively slight.

As regards *external* temperatures, it is not easy to fix any limit to the degree of either heat or cold, that may not be temporarily borne by the human body, without its being frozen or burnt to death. The skin is a conductor of low power. It is, in fact, an apparatus of isolation and regulation, being braced up and tense in cold weather, and relaxed in hot. Hence, to keep the skin healthy in winter time (and to be healthy it must be clean), is as necessary as to keep it warm. It is impossible to fix the precise time required to transmit the external heat or cold through the skin to the structures beneath, so much depending, in this respect, on the vitality of the integuments; and it is no doubt because of this difference of transmission, that heat and cold are so differently borne by different people.

Extreme external cold with proper precautions may be tolerated. Thus Captain Nares and his men lived for some weeks in 100 degrees of frost. I have known an omnibus driver frozen to his seat, and the reins to his hands, and at the same time rendered partially insensible, by exposure to cold on a severe winter's night, and yet recover after treatment. (*Case* 2.)

When strong and healthy warm-blooded animals are immersed in ice-cold water, they rapidly sink even if they are swimmers, death as a rule being rapid and free from pain. It has been supposed that this result is due to cramp preventing them making exertion. Dr. Richardson thinks it due to peripheral nervous shock and sudden exhaustion of the nervous centres, by the direct extraction of animal heat.

Still, cases of an opposite kind are recorded. Thus Dr. Richard-

son states he has known a kitten recover after two hours' immersion in ice-cold water. A case is mentioned where a man immersed in water at the freezing-point for twelve minutes was resuscitated (Dr. Belgrave). Richardson has shown how a carp, solidified by cold and apparently dead, may be restored to active life, by the cautious addition of warm water to the ice-cold water in which it was immersed. (See "*Med. Times and Gazette*," Feb. 18, 1871, p. 182.)

Equally remarkable are the extremes of heat that the human body will bear for a short time. Thus Chabert, the "Fire King," was in the habit of entering an oven, the temperature of which was from 400° to 600° F. (205° to 315° C.). In such cases the skin no doubt becomes protected by a covering of steam from the vaporization of the perspiration, the water gas formed being a bad conductor of heat, the evil effects that might otherwise occur being in this manner prevented.

A.—Effects of Extreme Cold.

The application of cold has on more than one occasion been employed homicidally (*Cases* 7 and 8). As a rule, however, death from cold is accidental, and is certainly not likely to be suicidal.

An extreme winter invariably increases the general rate of mortality, the increase being chiefly amongst children and the aged. Dr. Carpenter ("*Principles of Human Physiology*," 7th Ed., p. 497) quotes an interesting table from Quetelet's "*Essai de Physique Sociale*" (tom. I., p. 197), in which this fact is strikingly shown by the mortality at various ages in Brussels, during different months of the year. MM. Villerme and Milne-Edwards have given us similar statistics in respect to the mortality of children in French foundling hospitals. That a fall of temperature affects even the well-to-do classes in England, is shown by the "Deaths" column in the "*Times*" during the winter months.

It has been already noted that "although the surface may appear to be chilled by external cold, the underlying parts of the body are not, at first, necessarily lowered in temperature. If the skin be well developed, and possess the power to contract and maintain its tonicity, the resistance will be kept up sufficiently long to enable the organism within to accumulate heat for its maintenance at a natural temperature, so that when the skin relaxes, the surface will indicate by what we call 'a glow' the establishment of a defensive state. If cold be again applied, either by a blast of cold air or by the contact of wet clothing, the skin may again contract, when the process of heat-accumulation,

with the local determination elicited by the stimulus to the nervous system, will probably be repeated; but, unless the skin happens to be structurally and functionally developed to an extent scarcely possible at any part of the surface which is habitually covered by clothing, there will rapidly come a time when the external cold will no longer cause healthy contraction, and no reaction is likely to occur. When that moment arrives—and it may be very early in the case of weakly persons—the isolating properties of the integument will be exhausted, and either the body may be rapidly cooled, or a special call will be made on the apparatus of internal heat, leading to a rate of production which will establish what we call fever." ("*Lancet*," Dec. 6, 1879.)

It is of primary importance in considering cases of this kind that we should bear in mind that the evil effects of severe cold are greatly intensified by certain conditions. Thus fatigue, exhaustion from want of food (because internal warmth is not generated in sufficient quantity to make up for the loss) (see "*Edin. Med. Journ.*," XIII., p. 858), mental depression, habits of intoxication (*Case* 3), previous illness, in fact anything that tends to lower the physical powers, will predispose to the severe or fatal effects of cold. These two facts therefore are of importance to bear in mind forensically; (1) that a cold which would kill one person might do no harm to a second, and (2) that a cold which at one time might do no harm to a person, would, at another time, to the same person, prove fatal.

Again, a damp cold, such as wet clothing, a cold and damp atmosphere, partial immersion in water during cold weather, etc., is far more depressing and dangerous than a dry cold. A strong wind by accelerating evaporation has also a powerful influence in intensifying the injurious action of cold. [See Wunderlich on "*Temperature*," New Sydenham Society's Translation, pp. 128, 322, etc.; also a Lecture on the Effects of Cold by Prof. Parrot ("*Progrés Médical*," March 13, 1880).]

There are four cases in particular where exposure to cold may form the subject of legal inquiry; viz. (I.), *in new-born infants;* (II.) *in young children;* (III.) *in the insane; and* (IV.) *in those who have received serious wounds.*

(I.) *In New-born Infants.*—A living child, warm from the womb, soon succumbs if it is left unclothed, or if it is exposed to the air of a cold apartment, or if it is allowed to lie on cold stones, etc. A warm room and warm clothing are the indispensable requirements of a new-born child. (*Cases* 14 to 20.)

In cases where a mother is charged with causing the death of her child by its exposure, the medical jurist must consider four questions :—

(1.) Was the child mature, and was it born alive?

(2.) Does the post-mortem reveal either such diseased conditions or such marks of violence as may account for death? If not, are the appearances consistent with death from cold (see page 72), viz.:—

- (α.) An arterial color of blood.
- (β.) An accumulation of blood on both sides of the heart, and in the larger blood-vessels.
- (γ.) An extreme pallor of the surface of the body, with congestion of the viscera.
- (δ.) The existence of frost erythems.

(3.) Is the place where the body was found, the conditions under which it was exposed, and the temperature at the time of the exposure, such as would probably destroy the life of a new-born child?

(4.) Having regard to the history of the birth—was the exposure of the child (a) *accidental* (as in the case of rapid delivery whilst the mother is walking about and no one within hearing, syncope from loss of blood preventing her giving attention to the necessities of her offspring, or calling to others to assist her) (*Cases* 16 and 18); or (β) was it the result of *culpable negligence*, or (γ) of *reckless indifference* (such as the abandonment of the child), which constitutes *manslaughter* (*Cases* 14 and 15), (infanticide by omission)—or (δ) was the exposure an act of *wilful malice* (*murder*).

(II.) *In Young Children.*—A person may be charged with accelerating the death of a child by a course of treatment pursued ignorantly but with the best intention; whilst such treatment may be adoped by others in such manner as to escape the arm of the law, nevertheless with the certain object of getting rid of the child.

Although it is from the prolonged application of intense cold that dangerous symptoms usually occur, it is well to remember that not unimportant results may follow comparatively slight chills. (*Case* 1.) A cold bath in winter (that is, water at the temperature of the day), considering that the internal heat of the body is practically the same winter and summer, is a "luxury" of very doubtful general advantage (*Cases* 11 and 21). It is strange to note the satisfaction and glee with which some parents will tell how their children (including an infant,

may be of a few months old) go out, and that not unlikely in perambulators, every day in the winter, except when the weather is too bad;—or that they never miss their cold bath in the morning, breaking the ice for the purpose, as though there was some special virtue in such uncalled for ablutions;—or that they have never accustomed them to fires in their bedrooms, because they want them to grow up strong and hardy. Bare arms, necks, and legs may be a pleasure to the eyes of parents, but certain is it that they are not a luxury to the children, and far from seldom prove the starting-point of many serious ills in after-life. Given a temperature below 50° F., it is absurd to expose children to outdoor cold, if they are too young to walk or run. Perambulators were invented with far greater consideration for the feelings of parents and nurses than for the health of children. Admitting that with proper exceptions a cold sponge bath may be of service to adults, we doubt whether even in their case good can result from the daily total immersion of the body, whilst it is certain that in children such a course of treatment is dangerous in the extreme. "If the cold bath in winter be so used as merely to stimulate the organism to increased activity, and there could be some guarantee that the heat production corresponds to the heat parted with, it may be all very well. The proof of benefit is stimulation, viz., redness and steaming of the surface. But if stimulation be not induced evil must result, and the chances are too serious to venture."—("*Lancet*," 1879, I., p. 129.)

No doubt children are to be met with of more than ordinary strength, where the rapidity and intensity of the reaction saves them from the evil effects of the cold bath, but the risk even then is far too great to justify its daily repetition. The morning's bath (needful as a matter of cleanliness and to keep the skin healthy), should be a thorough washing with water between 75° and 80° F., reaction and healthy circulation being obtained by means of efficient friction.[1] The sleeping room for children should never be below 60° F., nor the living room below 65° F. Sufficient clothing, by which we imply coverings for the arms, legs and neck, should be provided. And all this is naturally suggested when we consider the necessity for maintaining

[1] It is commonly supposed that if a person be heated and perspiring, a *cold bath* (as for example a sea or river plunge in summer time) is injurious. Undoubtedly it is, if the person stops in the water too long, but not otherwise. On this point we would urge that every one must decide for himself what suits, and what does not suit, him; but speaking generally, we may say that such a cold bath is only dangerous when the person is cold, and not when he is hot, provided he does not stay in too long. Dr. Copeland calls special attention to the injurious effects of a cold bath when the body is much fatigued by muscular exertions, sexual excesses, and the like. For want of knowing or attending to this, Alexander the Great nearly lost his life.

warmth, more particularly in the case of children, and the danger certain to result from a prolonged application of intense cold to the entire surface of the body. That serious symptoms may arise from neglect of these precautions is certain, and the medical jurist may be called upon to consider how far they have been persevered in with criminal intent, under the plea of bringing up a child strong and vigorous.

(III.) *In the Insane.*—In mania the patient is frequently *insensible*, so far as his feelings are concerned, both to cold and heat; although he is equally, and perhaps even more *susceptible* to their effects than a person in health. Thus for all the madman cares he will lie naked out of doors on cold stones in the coldest winter weather; or, on the other hand, carelessly handle red-hot coals. Should such a case become one of legal inquiry, it must be remembered that exposure to cold under circumstances of apparent barbarity, may be the act of a madman, and not one of cruelty forced upon him, either as a punishment by his keeper, or for criminal purposes by those whom it may be supposed have an interest in his death.

In *Case* 21 it would seem that a cold shower bath at 45° F. (7.22° C.), followed by a dose of tartar emetic, caused the death of a lunatic in fifteen minutes.

(IV.) *In the case of the Wounded.*—The increased danger of wounds resulting from exposure to cold, may prove important medico-legally. Undoubtedly a wound from which a person would rapidly recover if the injury were properly cared for, might under circumstances of long-continued exposure, assume serious importance, and even endanger life by inducing complications, such as tetanus. (See Paper by Professor Verneuil, "*Gaz. des Hôp.*," November 13, 1879; "*Med. Times and Gazette*," 1879, II., p. 601.) An important forensic question of this nature is possible, seeing how a comparatively slight wound administered without murderous intent, might in this manner prove fatal.

Beck has collected a number of cases of sudden death *from drinking cold water when heated.* We believe these cases do not strictly belong to the effects of cold, but are far more akin to *heat-apoplexy.* Many people drink freely of the coldest drinks and partake of ices when very hot, with perfect impunity. When the use of ices first became common in America and England, there were dreadful prognostications as to their effects, which certainly have, for the most part

been falsified. Still, cases of sudden death occur from time to time after the ingestion of great quantities of cold water by persons violently heated. Such results may be explained in various ways :—

(1.) That in most of the cases there has been extreme fatigue, and the body subjected to great heat. Death may therefore result from syncope, exhaustion, or solar apoplexy.

(2.) In others, the ingestion of a large quantity of water may cause the red blood corpuscles to swell inordinately, and so produce blocks (thrombosis) and consequent congestion in the capillaries of the lungs and other organs.

(3.) In a few, death may be due to the shock which the fall of temperature produced by the cold liquid has caused to the heart.

Symptoms produced by Cold.

The application of extreme cold to the surface of the body effects a manifest depression of the heart's action. The primary results are certain painful feelings, and a purple lividity of skin, upon which blisters frequently form. These are succeeded by headache and occasional vomiting (*Case* 1), numbness, anæsthesia ("*Lancet,*" 1873, I., p. 779, and "*Med. Times and Gazette,*" 1879, I., p. 347), and a marked pallor of the skin. With the hyperæmic condition of the organs consequent upon the blood being forced inward, we often find congestion of the genitals and priapism. A low temperature and a feeble weak pulse are commonly noted, but a high temperature has also been recorded. (*Case* 1.) Stiffness of the limbs, chiefly due to impaired contractile power of the muscles, torpor, and a condition of coma resulting from congestion of the nervous centres, and from which the sufferer can only be roused with great difficulty, follow in due course. (C. Bernard found that the blood absorbed less oxygen at a low temperature. "*Leçons,*" 1859, p. 114.) Lastly, a complete suspension of respiration and of the heart's action ensue, and the victim perishes (*coup de froid*).

We are indebted to Lieut. Payer for an interesting account of the effects of an intense arctic cold. We must, however, remark that some of the symptoms detailed, read as though they were the results of scurvy, rather than the effects of severe cold pure and simple. (Geographical Society of Vienna—see "*London Med. Rec.,*" July 15, 1875.) He states that the men were unable to touch a metal cup with their lips or hands, because it felt like red-hot iron. He also remarks that the cold seemed to paralyze the will, so that the men, from the un-

steadiness of their gait, stammering talk, and slowness of mental operations, seemed as if intoxicated,—effects no doubt due to congestion of the brain. Further, the cold created a tormenting thirst. If to relieve this, snow was put into the mouth, it speedily caused inflammation of the throat, palate, and tongue. The smell and taste, he remarks, were much enfeebled. If locomotion was stopped, owing to the sleepiness induced, the soles of the feet rapidly became insensible. The secretion of the eyes and nose was greatly increased, whilst perspiration almost entirely ceased. (A further account of the effects of severe cold and privations are recorded in *Case* 9.)

Further we may add that severe nervous symptoms, such as tetanic convulsions and delirium (*Case* 1), have been recorded.

Amongst *the minor effects of cold*, chilblains and sores on the extremities, which are often slow to heal, may be mentioned. (*Case* 10.) In what is called *frostbite*, the part which at first was livid, cold, and numb, becomes almost bloodless, of an ashy grey color, perfectly insensible, and much reduced in bulk. The nose, ears, or extremities are the parts most likely to suffer. ("*Lancet*," 1871, I., 26, 60.)

A case of gangrene of the lungs and death, following immersion in cold water, is recorded. (*Case* 11.)

Sometimes death from cold is very rapid (*Case* 21), whilst at other times it takes place after a considerable interval. (*Cases* 1, 13.) Severe cases not unfrequently recover if promptly treated. (*Cases* 2, 12.)

The period of reaction is not without its danger. As a fact the depression of the heart's action mentioned as resulting from the application of cold, is liable to increase rather than to lessen, as the cold is discontinued. (See Draper, "*Amer. Journ. of Science and Art*," IV., Dec., 1872.) Under ordinary conditions, a series of symptoms occurs during reaction, similar in many respects to those succeeding the shock resulting from a blow. (*Richardson.*)

If the parts already subjected to a great cold be warmed too suddenly, *gangrene* is apt to set in. ("*Med. Times and Gazette*," 1871, II., p. 678.) No doubt in cases where the patients are otherwise out of health, this result is specially liable to occur. (*Case* 12.) Further, the condition of the shins and ankles of persons (more especially in the case of the old and ill-fed) who during or after exposure to severe cold have crouched over fires, is often of such a nature that it might be supposed they were suffering from contusions and bruises the result of violence. Baron Larrey ("*Méd. de Chirurg. Milit.*," tom. III., p. 60) records how during the French campaign in Poland, for a few days before and after the battle of Eylau (Feb. 7th and 8th, 1807),

there was a cold ranging from 10° to 13° below zero of Réaumur (= 20° to 25° below freezing F.). Snow fell during most of the battle. But though the troops were day and night exposed to this most inclement weather, and the soldiers of the Imperial Guard in particular were nearly motionless for twenty-four hours, there were no evil results. But on the night of the 9th of February, a sudden thaw commenced, and immediately a great number of soldiers presented themselves at the ambulances, complaining of severe numbness, pain, and pricking of the feet. Some had merely symptoms like those of chilblains or frostbite, but many had gangrene, the toes having already become dry and black, whilst in some the entire foot had perished. Mr. Solly mentions a similar case. (South's "*Chelius*," Vol. I., p. 128; Druitt's "*Surgery*," ch. V., p. 156; Miller's "*Principles of Surgery*," p. 275.)

In *Case* 12 we have recorded some of the more severe effects of cold in the case of an unhealthy and diseased constitution.

During reaction a temperature indicating fever frequently results.

Treatment of Persons exposed to Extreme Cold.

The great principle of treatment is *to restore the warmth of the part gradually.* To do this it should be rubbed with snow or iced water, substituting after a time cold water for the iced water, and at a later period dry friction. No fire should be in the room (if a small one) where the patient is, or if the room is large, he should be at a considerable distance from the fire. The limb, when a certain warmth has been attained, should be wrapped in some non-conducting material such as cotton-wool. If the whole body be much chilled, the patient should be put to bed in a room of moderate temperature, and dry friction or stimulating embrocations employed. Hot coffee ("*Lancet*," 1876, II., p. 844), or hot wine and water should be administered, and for some reasons the former is preferable. Alcohol certainly should be avoided during exposure to cold, but may be advantageously given afterward. ("*Lancet*," Jan., 1876.)

To guard against the evil effects of cold, the use of non-conducting clothing (furs, flannels, etc.), a tolerably liberal diet, and artificial warmth and exercise, are the chief means at our command.

We must not omit to mention the *uses of cold in surgery*, with which the name of Esmarch is especially connected. The physician is often taunted with employing both heat and cold in the treatment of inflammation, using the one if the other fails. The key to this apparent paradox is to be found in the fact that the effects of extreme

heat and of extreme cold on the body are in many respects very similar. (*Case* 11.) As an example, both produce vesications.

Post-mortem Appearances.

Rigor mortis (for which the stiffness of a frozen body must not be mistaken) generally sets in slowly, and lasts a long time.

If the medical jurist be asked whether, judging by the post-mortem in any given case, *exposure to cold was, or was not, the primary cause of death*, he should, we are convinced, rely rather on common sense than on any special post-mortem appearances. The absence of other signs and causes of death (especially the absence of marks of violence)—the season of the year—the place where, and the circumstances under which, the body was found—the external temperature, etc., must in such cases be specially considered.

Dr. Ogston, who has recorded the results of the post-mortem inspection (in all) of 16 bodies after death from cold ("*British and Foreign Medico-Chirurgical Review*," 1855), states that, given the absence of any other obvious cause of death, and the presence of the following four post-mortem appearances, the medical jurist would be justified in stating, if not with absolute certainty at any rate with high probability, that death resulted from exposure to cold. He, however, remarks that in children the appearances were not so characteristic as in adults.

(1.) *An arterial hue of the blood generally*, except when viewed in mass within the heart. In two of the cases this bright color of the blood was not observed by Ogston. This arterial blood tint is mentioned by Blosfeld of Kasan (Henke's "*Zeitschrift*," 1860) as occurring in his nine cases of death from cold, and by Dr. Hilty in his case (*Case* 3). Neither Krajewsky, however (Henke's "*Zeitschrift*"), in his five cases, nor Dieberg (Casper's "*Vierteljahrss.*," 1864) in his ten cases, mentions this peculiar blood coloration.

(2.) *An unusual accumulation of blood on both sides of the heart, and in the blood-vessels of the chest.*—Quelmalz (see *Case* 4), Blosfeld (as above), Dieberg (as above), and Hilty (*Case* 3) agree in this, but Krajewsky (as above) has not mentioned it as occurring in his cases.

(3.) *Pallor of the general surface of the body, and congestion of the viscera most largely supplied with blood.* (*Cases* 3, 5, 20.)—In three of Dr. Ogston's cases congestion of the brain, and in seven congestion of the liver, was only moderate. Pallor of the skin was remarked by

Ogston in all the cases of children but one. In *Case* 4 the viscera were not materially congested, but this case can scarcely be regarded in the true sense as a death from cold. This condition of the surface and viscera is mentioned by Blosfeld, Krajewsky, and Dieberg as having been noted by them.

(4.) *Irregular and dusky-red patches on limited portions of the exterior of the body, even in the non-dependent parts* (frost-erythems). These patches contrast strongly with the pallid skin. (*Case* 3.) This condition was noted by Ogston in all his cases occurring in children. Blosfeld, Krajewsky (who explains the existence of these patches by the removal of the corpse to a warm temperature), Dieberg (who accounts for them by the action of cold on the *dead* body), and Hilty, have severally recorded these frost-erythems as occurring in their cases.

Quelmalz records having found polypous concretions in the large veins and arteries in one case of death from cold. (*Case* 6.)

Certain parts and organs of the body may be found frozen. (*Case* 4.) But this, probably, as a rule is a post-mortem, and not a life phenomenon.

In *Case* 4 the post-mortem appearances did not correspond with death from the effects of cold. This suggests the remark, that because a body is found in the snow or in ice, death is not necessarily the result of cold. In the case in question, there is little doubt that a fit was the true cause of the fatal ending, and that the occurrence of this fit out of doors on a cold day was a mere coincidence. This would account, moreover, for the slight abrasions found on the fingers in the case in question.

Putrefaction does not occur at a freezing temperature. If, therefore, a *decomposed* corpse is taken out of the ice or snow, it is practically certain, even supposing the person died from cold, that the body meantime had been subjected to a warmth sufficient to develop and assist the putrefactive process. Of course, the chances in such cases are that the person did not die from cold at all, but that some days after death (that is, after putrefaction commenced), the body had been brought from a warm place to the spot where it was found. If, previously to finding the decomposed body, there had been a long continuance of cold weather, the probability that such was the case would be greatly increased. (*Case* 19.)

B.—Effects of Extreme Heat.

(*Sunstroke; Thermic Fever; Insolation.*)

[For papers and lectures on sunstroke, see "*New York Med. Journal*," XII., p. 90; "*Med. Times and Gazette*," March 16th, 1878, p. 271 (Dr. Handfield Jones); "*British Med. Journal*," July 9th, 1870, p. 35 (Dr. Henry Thomson); Aitken's "*Medicine*," II., p. 380.]

A heat that raises the body temperature above the normal, is as fatal as a cold that reduces it below the normal. In certain American towns during the hot weather, the mortality from "sunstroke" has at times been enormous. Thus at St. Louis, the temperature from July 10th to 20th, 1878, ranged from 83° to 100° F., and during this period one-third of the mortality was ascribed to the heat. (Dr. Kennard, "*New Orleans Med. Journ.*," October, 1878.) At New York the deaths from sunstroke have been at times very numerous. ("*Lancet*," July 23d, 1870.)

Dr. Horatio C. Wood, to whom we are indebted for much careful work on the effects of heat ("Thermic Fever, or Sunstroke," Trübner, 1872; "*Lancet*," July 27th, 1872; "*Philadelphia Medical Times*," August 5th, 1876), considers that there are three classes of cases confounded under the general term "sunstroke." In the *first class* (which is very rare), we have acute meningitis or phrenitis (*coup-de-soleil*). In the *second class*, we have heat exhaustion with collapse, accompanied by a rapid, feeble pulse; a cool, moist skin, and a tendency to syncope. In the *third class*, we have thermic fever, and to this the name sunstroke is, he considers, a misnomer. It is not, in his opinion, the sun merely that is the active agent (for attacks of sunstroke occur at night as well as by day), any more than it is blood-poisoning; but it is the action of external heat, independently of its source—in other words, it is a matter of indifference whether the source of heat be the sun, a factory, a hot-house, a sweating room in a Turkish bath (in which bad effects have been recorded) (*Case* 22*a*), an engine-room, etc. The effects of the heat, moreover, are always far more severe when they occur to those unaccustomed to an abnormal temperature. (*Cases* 22, 25.)

But something more than heat is required to induce thermic fever. An impure air and an atmosphere saturated with moisture by which evaporation from the skin is interfered with (evaporation being the principal means of effecting a cooling of the body), are most important factors.

The sweating room of a Turkish bath should not be heated by a flue passing round the room, but should be a well ventilated apartment, the ventilators being placed level with the floor, and the heat maintained by a constant influx of pure hot air. By the latter process the air will be hot but pure; whilst by the former, the same air—polluted by the inmates of the apartment, and more or less saturated with moisture—is heated over and over again, the door being the only chance of admitting fresh air.

I have had an opportunity of watching an excellent experiment, in illustration of the prolonged action of a high temperature, conducted by Mr. Bell, of the Grosvenor Terrace Turkish Baths, Westminster, on himself. He remained in the hot room of the bath, day and night without once leaving it from 9 A.M. on Monday, August 9th, to 9 P.M. on Friday, August 13th, 1880. During this period the average day temperature of the room was 140° F. (60° C.), and the average night temperature 125° F. (51.6° C.). His health in no respect suffered from the experiment. His bowels were somewhat costive, and his urine high colored, and (as we should expect) small in quantity. Some of the detailed results of this experiment may be interesting:—

	Weight.	Temperature.	Pulse.	Diet.
	St. Lbs.			
Monday, 9 A.M.	11 7½	—	—	Mutton broth, a little mutton,
12 Midnight.	—	98.4	120	vegetables, bread and butter, watercress.
Tuesday, 9 A.M.	11 2¼	—	—	Ditto, but no meat.
Wednesday, 9 A.M.	11 1¼	100.0	122	Ditto, with soda-water, lemons,
Wednesday, 8.55 P.M.	11 4	—	—	and a water-melon.
Thursday, 9 A.M.	11 1½	—	—	Ditto; a small quantity of whis-
Thursday, 2 P.M. ...... (after dinner)	11 3¼	99.5	80	key freely diluted was taken morning and evening.
Friday, 9 A.M.	11 2	—	—	Ditto.
Friday, 9 P.M.	11 6	99.5	72 (regular.)	

The same fact respecting the character of the heat is observed in other cases. Thus, a temperature by no means oppressive, if the atmosphere is pure, becomes absolutely intolerable in the narrow, ill-ventilated, close courts and alleys of towns. Again, a heat easily tolerated if the air is not saturated, becomes unbearable if it is saturated. This is the explanation of the stifling character of the air after a thunderstorm on a hot day. External heat can be easily borne if the

air is pure and unsaturated, for the skin then permits evaporation, and by evaporation the internal temperature of the body is regulated. If, however, from any cause whatsoever, the skin fails as an evaporating, and therefore as a cooling surface, a condition of hyperpyrexia results, with a disturbed balance of the circulation and cerebral irritation (thermic fever), gradually increasing till it reaches the point of death.

The phenomena of sunstroke and heat apoplexy, depend on the action of the superheated blood on the nerve centres and large internal organs. Quoting Dr. Wood's words: "Under the influence of external heat the temperature of the body rises, until at last a point is reached at which the heat paralyzes, by over-stimulation of the controlling centre regulating animal heat: then a sudden additional rise of temperature with a corresponding increase in the severity of the symptoms occurs."

There is no doubt that in exceptional cases an intense heat may cause a condition closely allied to concussion of the brain, death resulting from paralysis of the heart's action; or that if a person be disposed to apoplexy, or have a weak or diseased heart, he may, as has happened in the Turkish bath (*Case* 22*a*), die suddenly at the very outset. It is these exceptional cases which have given rise to the incorrect term "sunstroke."

It has been remarked that the *morning* sun is specially dangerous. This has been accounted for by supposing that the injurious effects are chiefly due to the direct rays of the sun striking the nape of the neck; and there is considerable evidence in support of this view. Some have supposed that the strong glare of an intense sunlight is alone sufficient to produce sunstroke. This is doubtful; but it is certain (and the fact is not unimportant in its relation to electric lighting) that an intense actinic light is itself a powerful irritant. Other observers, having remarked that on some days cases of sunstroke are numerous, whilst on others, although the temperature has been as great, the cases were few, have supposed that the electrical condition of the atmosphere may play its part. Of this by no means improbable conjecture, however, we have no experiments in proof; but that something more than heat is required to produce thermic fever is, as we have said, a matter beyond question.

Prophylactics.—The safeguard against sunstroke is the healthy play of all the functions. Whatever checks elimination, or induces nerve-weariness, or embarrasses the normal working of the organic system, predisposes to heat apoplexy. ("Let the sun have no ally in liquor.") Temperance, sobriety, and cleanliness are the chief points to

be observed by residents in hot climates. The wearing of flannels is, under all circumstances, advisable. A daily bath, an occasional purgative, and, when in the sun, some method by which the direct rays may be prevented from reaching the nape of the neck, are the special precautions called for.

Sunstroke frequently attacks soldiers on the march. Unless unavoidable, it should be an axiom with commanders that troops should not march, or practise, or be reviewed, during the hottest hours of the day. The weight of the knapsack, and tight articles of dress, such as the collar around the neck, contribute to the fatal results recorded by exposing soldiers to the extreme heat of the sun.

Symptoms produced by Extreme Heat.

The symptoms vary in degree. Thus in a *mild case* there may be merely a momentary loss of consciousness, followed by drowsiness, a condition in children not unlikely to be overlooked. Or again there may be headache with prostration, a hot skin, a small weak compressible pulse, but without other signs of fever, and with no appreciable mischief, functional or organic, of any special organ except depression of the heart's action. Or again in a bad case, there may be profound coma lasting for several days.

The symptoms at times set in suddenly (*Cases* 23, 24 α and β, 32, 36 β, 38), but as a rule they are not of instantaneous occurrence. Certain premonitory symptoms, such as headache, tinnitus aurium, and vomiting, are commonly recorded. (*Cases* 34, 37, 40, 45.) Often the bad symptoms set in at night after a long day's work, accompanied by great muscular exertion, in the sun. These are after a time followed by confusion and temporary loss of sight, flushed face, great difficulty in breathing, stupor, and in bad cases coma. A case of recovery, even when the coma was very marked, is recorded. (*Case* 26.) Sometimes *petechiæ*, or spots like those of typhus, make their appearance. (*Case* 31.) The skin is dry and hot, and the temperature invariably very high (100° to 110° F.). (See *Cases* 26, 30, 35 α and β, 39.) The pupils are generally dilated in the earlier, and *contracted to a fine point* in the later stages. (*Cases* 24 α and 42.) As a rule they always appear contracted when the attack comes on slowly. (*Cases* 34, 35 α and β, 36 α, 37, 41.) In one case inequality of the pupils was remarked. (*Case* 32.)

We are indebted to Dr. Katzenbach ("*New York Med. Journ.*," XVII., p. 91) for a careful summary of the symptoms noted in 55

cases treated at the Bellevue Hospital. Of these, 44 were admitted in an unconscious state. The skin was invariably dry and hot, and the cases in which it was pallid and those in which it was congested were about equal in number. The pulse ranged from 68 to 168. It was generally frequent, small, and weak, but in some places it was slow, full, and strong.

The *respirations* were generally increased in frequency—sometimes stertorous, but in others quiet and easy. Pulmonary congestion, marked by cyanosis and moist râles in the chest, was remarked in nearly every case.

The temperature varied greatly. Thus it was found to be :—

100° F.	to	105°	in	43	cases.
105°	"	107°	"	27	"
107°	"	108°	"	16	"
108°	"	110°	"	10	"
110° and over			"	3	"

Vomiting occurred in 13 cases, and purging in 19—the dejections being yellow, liquid, and offensive. Vomiting and purging together, occurred in 8 cases.

The urine was always small in quantity. In one case it was alkaline, and in one albumen was present. Convulsions were not infrequent, being epileptiform in 4, tetanoid in 12, and of a mixed nature in 3. (*Case* 23.)

Delirium occurred in 7 cases, and in four cases it was associated with convulsions. Hemiplegia occurred in one case only. No paralysis of any kind was noted in the remaining 54 cases.

It would appear, therefore, that the symptoms are somewhat variable. Thus in Dr. Thin's cases (*Case* 46), there seems to have been cerebro-spinal lesions, a similarity to typhus (ζ), and disordered digestive symptoms (η). And this can be explained by supposing that the heat, which undoubtedly causes functional paralysis of certain nervous centres, attacks different centres in different people. Thus it may be that the medulla in one person, the cardiac plexus in a second, and the solar plexus and its offshoots in a third, may be severely affected. And so in some instances, abdominal symptoms (*a heat affection*) (*Cases* 34, 41), in others spinal symptoms (*Cases* 37, 40), and in others cerebral symptoms (*heat-stroke*) (*Cases* 22, 23, 26, 27, 29 α and β, 33, 42) may preponderate.

The specially striking symptoms of intense heat are undoubtedly the high temperature, the thirst, and the dryness of the skin. Death

may result from genuine apoplexy in those predisposed to it, but most often it is due to apnœa, and sometimes, as Dr. Aitken has pointed out, to rapid asthenia (syncope). Considering the power of intense heat as a depresser of cardiac activity, the failure of the heart is always one of the chief dangers of sunstroke.

Of the 55 cases recorded by Katzenbach, 23 died. The shortest duration of the attack in his fatal cases was ten minutes, although a case is recorded where death ensued after five minutes (*Case* 43), whilst the longest duration was three days.

In the cases that recovered, a few were well in one hour, whilst in some the severe symptoms lasted for 24 hours, and even a much longer time. (*Cases* 23, 24 *α*, 31.) As a rule the patients cannot be pronounced out of danger, even in the mildest forms, in less than 11 or 12 hours. There is hope, however, in the most severe cases. (*Cases* 31, 44.)

Sunstroke is disposed to leave behind it a train of sequelæ. Of these the most serious are various neuroses, such as epilepsy, catalepsy (*Case* 42), and paralysis which may be transient or permanent (*Cases* 31, 44); also a weakened condition of the liver and digestive organs, etc.

Treatment.

(For reference to rules of treatment see Sir J. Fabian, "*Brit. Med. Journal,*" Aug. 12, 1876, p. 223.)—The collar, necktie, and any tight articles of dress should be immediately removed, and the person carried to a cool and scrupulously quiet place, and placed in a recumbent position. All clothing, but one thin covering, should be removed. Ice should at once be applied to the head and back of the neck, and in bad cases the body should be rubbed with ice or iced water. (Dr. Wood considers that the ice-water bath should be persevered in until the mouth temperature is reduced to 100° F.) When the patient can swallow, a little weak wine and water may be administered, together with light nourishment, such as milk or beef-tea. Counter-irritants are useful in certain cases. (*Cases* 24, 40.) The after-treatment must depend on the symptoms which develop themselves.

As regards bleeding, some, as Dr. Richardson, speak of it as *the* remedy. ("*Med. Times and Gazette,*" Dec. 17, 1870, p. 695.) It undoubtedly proved useful in *Cases* 23 and 27, but failed in *Case* 36 *α*. The general opinion, however, of practical physicians, such as Dr. Wood, is against it.

Dr. Wood recommends quinine, except in the cardiac variety, to be

given either by the mouth or preferably hypodermically (one grain in this form being said to be equal to four grains administered by the mouth), as a drug of great service in preventing a rise of temperature. The details of recorded cases clearly indicate its great value. (*Cases* 29 α and β, 33, 38.)

Katzenbach records that in many of his cases morphia was administered with marked benefit.

The hypodermic injection of atropine (*Case* 28) has been advocated by Dr. Barnett.

If there is much vomiting a sedative dose of opium and calomel is indicated.

If there is collapse Dr. Wood recommends a warm-water bath.

The symptoms which set in after the subsidence of the first symptoms (headache, distress, and mental incoherence), yield to mercurials and to free blistering of the neck.

Post-mortem Appearances.

The post-mortem appearances are as a rule negative, *i.e.*, no constant lesion seems to occur. In some cases nothing abnormal has been noted. (*Case* 22.)

Rigidity occurs early and putrefaction rapidly after death, livid spots and petechiæ being commonly found on the body. (*Case* 35 α.) A blanched condition of the body has also been noted. (*Case* 24 β.) Levick has shown that the appearances after death from extreme heat, are almost identical with petechial or spotted typhus.

The brain and its membranes are generally congested, and serum in quantity is commonly found in the ventricles. (*Cases* 35 α and β.)

The heart becomes unusually rigid and of a dusky grey color after death. Putrefaction being rapid, the heart at the post-mortem may be found in a relaxed condition. As a rule the left ventricle is rigidly contracted, whilst the *right* heart and pulmonary arteries are gorged with dark *fluid* blood. (*Dr. Wood* and *Dr. Kennard.*) (Dr. Kennard considers death in sunstroke is due to paralysis of the heart, dependent on derangement of the nervous centres.)

The lungs are usually highly congested (*Case* 32) and œdematous, more especially posteriorly. They often exhibit the conditions characteristic of apnœa (*Case* 35 α), but this is by no means always the case. (*Case* 35 β.)

The abdominal viscera, especially the liver and spleen, are commonly more or less congested.

The brain and kidneys are usually moist and œdematous, whilst the liver, heart, and muscular tissue are more than ordinarily dry. (*Arndt.*) The blood after death from sunstroke is frequently fluid, from impaired coagulability, and is also very dark in color. (*Cases* 32, 35 *a* and *β*.) It is said to be acid, and to contain an excess of urea. (*Oberneier.*)

Dr. Rudolph Arndt states as his experience (in which Dr. Wood, Dr. Kennard, and others agree) that in sunstroke we have blanching (anæmia) of the parenchyma of the organs, and as a result, a distended condition of all their vessels above a certain size, with dark-colored, uncoagulated blood. The brain tissue is in his experience anæmic, although the ventricles are distended with fluid and the large veins and sinuses full of blood. Similarly the heart, liver, kidneys, intestines, and bladder are in reality anæmic, although the larger vessels are engorged. Hence sunstroke in his opinion, is not hyperæmia, but rather anæmia, of the brain, for the capillaries and minute vessels are well-nigh empty. In the lungs the hyperæmia prevailed uniformly. ("*Brit. and Foreign Med.-Chir. Review,*" Oct., 1875.)

ILLUSTRATIVE CASES.

1. **American Journal of the Medical Sciences, Oct., 1861, p. 432.**—(*Dr. Hartshorne.*)—Male, æt. 14. Exposure for a few minutes in his night-shirt, at an open window on a winter's night. [The temperature of the night was 50 degrees lower than that of the day.] Death occurred on the third day. The symptoms were headache, drowsiness, vomiting, high temperature, hard and quick pulse, and delirium. [In fact, the symptoms were not unlike those of sunstroke.] (Pages 66, 69, 70.)

2. **Edinburgh Medical and Surgical Journal, Vol. I., p. 302.**—(*Dr. Kellie.*)—Recovery from the effects of cold. (Pages 63, 70.)

3. **Casper's Vierteljahrss., 1865, II., p. 140.**—(*Dr. Hilty, of Wiedenberg.*)—Male, æt. 57, intoxicated. Died from exposure to cold during a severe winter's night.

Post-mortem.—Blood crimson. Both sides of the heart full. Congestion of internal viscera, especially of the liver and kidneys. Numerous patches of redness found on the skin and in non-dependent parts. Bladder distended with urine. (Pages 65, 72, 73.)

4. **Casper's Forensic Medicine, Vol. II., p. 280.**—(*Case* cccxxiii.)—Female, æt. 55, found on the ice, dead and stiff.

Post-mortem.—No signs of injuries, except abrasions on the knuckles, probably due to her having had a fit, and throwing her arms about. Brain appeared half frozen, the cerebral veins and sinuses being only moderately full; lungs normal; trachea pale and empty; right side of the heart fairly full of blood, and the left side distended; blood natural; liver moderately congested; kidneys and spleen normal; ascending vena cava congested.

Opinion.—Death the result of cardiac apoplexy, possibly from the effects of cold, but more likely from a convulsive attack whilst walking over the ice. (Page 72.)

5. **Edinburgh Medico-Chirurgical Transactions, Vol. I., p. 84.**—(*Dr. Kellie.*)—Death of two persons on the night of the 3d of November, 1821, from exposure to cold.

Post-mortem.—The appearances exactly corresponded in both cases. External signs not well marked. The brain and its membranes were congested, the sinuses being loaded with black blood ; three or four ounces of serum were found effused in the ventricles and at the base of the brain. Stomach pale ; intestines reddened ; liver congested. (Page 72.)

6. **Haller's Disputationes, Vol. VI.**—(*Post-mortem by Quelmalz after death from the effects of exposure to cold.*)—Vessels of the brain turgid, with serous lymph effused into the ventricles. Large veins and arteries filled with polypous concretions. (Page 73.)

7. **"Annales d'Hygiène," Vol. VI. (1831), p. 207** ; *see also* the "Medical Times and Gazette," July 21st, 1860, p. 61.—(*Dr. Ozanam, of Lyons.*)—A man and his wife were tried at Lyons for the manslaughter of his daughter and her stepchild, a girl æt. 11. The mother, after a long course of starvation and ill-treatment, had compelled the child to get out of bed on a cold morning in December, and get into a barrel filled with cold water. Although extricated by a servant after having been immersed for some time, she was again replaced in the water, and finally died. The woman was condemned to imprisonment for life. The child doubtless succumbed to the effects of cold added to [1] previous ill-usage. (Page 64.)

8. **R. v. Lovell.**—(*Gloucester Lent Assizes*, 1853.)—In this case a woman was convicted of the manslaughter of a child aged four years. The child, already diseased, was put under a spout in cold January weather, and water pumped over her. Although the medical witness did not think this accelerated the death, the jury (as we think rightly) did, and found the prisoner guilty. [The late Justice Talfourd remarked that the verdict was based on common sense and reason, although contrary to the opinion of the medical witness !] (Page 64.)

9. **Edin. Med. Journal, March, 1868, p. 859.**—(*Mr. C. E. Smith.*)—An account of the effects of long protracted exposure to cold and privations in the case of 50 persons belonging to the ship Diana, who were compelled to winter in lat. 70° 30′ N., with only two months' provisions on board. The weekly allowance was 3 lbs. of bread, 3½ lbs. of salt meat (afterward reduced to 2 lbs.) and ½ lb. of flour per man. Scurvy made its appearance after four months. The men of medium size, dark complexion active habits, and cheerful temperament enjoyed the greatest immunity. All were affected with scurvy by April, when the ship arrived in Shetland. (Page 70.)

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[1] Dr. Ozanam uses the word *assideration* in reference to cold being the cause of death. It is equivalent to our word "concomitant."

[In the march of the French soldiers from Moscow, it is reported that they suffered severely from hunger and cold. Insensibility and disposition to sleep came on whilst they were marching, and although able to continue their march for a short time, they could not understand anything addressed to them.]

10. **Lancet, Jan. 14, 1871.**—Male, æt. 14. Acute inflammation of the feet from exposure to cold, with large vesications. The toes were shrivelled and of an ashy grey color. (Page 70.)

11. **Lancet, July 8, 1871, p. 47.**—(*Dr Leared.*)—Male, æt. 49. Gangrene of lungs, following immersion in cold water. Death. (Pages 66, 70, 72.)

12. **Medical Times and Gazette, Dec. 2, 1871.**—(*Mr. Hutchinson.*)—Female, æt. 30. Suffered from intermittent hæmatinuria. Circumscribed gangrene of the skin, and of the tip of the nose and parts of the ear following exposure to cold. The sloughs separated, and she recovered after a long time. (Pages 70, 71.)

13. **British Med. Journal, 1870, I., p. 213.**—Male, æt. 9. Death from cold. (Page 70.)

14. **R. v. Walters** (*Oxford Autumn Assizes,* 1841).—The prisoner was delivered of a child whilst travelling in a wagon. She carried it for some distance, but afterward abandoned it, leaving the infant in the road where it was afterward found dead, the death evidently resulting from exposure to cold. Live birth was proved by witnesses who heard the child cry *after* the mother had left it. The prisoner was found guilty, and sentenced to 10 years' transportation. (Pages 65, 66.)

15. **R. v. Waters** (*Exchequer Chambers, Jan.,* 1849).—A woman was convicted with causing the death of her child by leaving it exposed on a dust heap. (Pages 65, 66.)

[In this case there was an appeal, on the ground that the count charging the woman with causing the death of her child as above, was not good. Conviction affirmed.]

16. **Ann. d'Hyg., 1868, 2, 173.**—A girl suddenly delivered of a child whilst sitting on a night-stool. She stated that she fainted, and on recovery found the child on the floor dead. The child had breathed. The cord had also been cut, and there were no signs of violence on the child. Medical evidence showed that death was caused by exposure and want of proper attention. The child, however, was a weakly one. The girl was

found guilty of causing its death by imprudence, inattention, and negligence. Sentence, two years' imprisonment. (Pages 65, 66.)

17. **Horne's Vierteljahrss., 1866, 2, 148.**—(*Dr. Otto.*)—Infanticide by exposing a child to cold. (Page 65.)

18. **Casper, Vol. II., p. 278.**—(*Case* cccxxi.)—A female, unmarried, delivered suddenly, whilst sitting down (January) with a washing basin beside her. She lost her senses, and on recovery found the child had fallen on its back into the basin. It was cold and dead. When she became sensible she placed the body without any covering on some dirty clothes in a basket. *Post-mortem:* Body mature; signs of death from apoplexy. (Pages 65, 66.)

[Casper accounts for the death, by the child lying exposed naked in a cold basin to the cold atmosphere.]

19. **Casper, Vol. II., p. 279.**—(*Case* cccxxii.)—A male child rolled in rags, found in the snow in an advanced state of putrefaction. It was proved to have been born alive. (Pages 65, 73.)

[Casper decided (from the state of putrefaction) that the child had been dead some time before it was placed in the snow; and that *it did not die of cold* (a conclusion open to question.—C.M.T.).]

20. **Casper, Vol. II., p. 281.**—(*Case* cccxxiv.)—A mature female child found dead and frozen in a loft (February).

Post-mortem: All the cavities of the heart were distended with dark and partially frozen blood. Lungs congested. Larynx and trachea pale and empty. Liver congested. Casper decided that cardiac and pulmonary apoplexy, possibly due to internal causes but probably to exposure to cold, was the cause of death. (Pages 65, 72.)

[Casper decided the child was born alive.]

21. **Taylor, Med. Juris., II., p. 488.**—Male, æt. 65, insane, had first of all a shower-bath given him (the water being 45° F.), and afterward a dose of tartar emetic. The man died in a quarter of an hour after he had taken the medicine. (Pages 66, 68, 70.)

[The coroner's jury brought in a verdict of manslaughter against the medical man, but the grand jury threw out the bill. The treatment was proved to be bonâ-fide.]

22. **Taylor, Med. Juris., I., p. 138.**—A male, by business a grocer, and not accustomed to great heat, undertook the duties of stoker on an Aberdeen steamship. Whilst at work he was seen suddenly to fall on the floor insensible. When carried on deck he was found to be dead.

Post-mortem: Effusion of serum into the ventricles of the brain. No other abnormal appearances noted. (Pages 74, 78, 80.)

22a. British Med. Journ., June 3, 1876, p. 706.—Death in a Turkish bath. (Page 76.)

23. Medical Times and Gazette, Aug. 27, 1870, p. 236.—(*Mr. Salter.*)—Male, æt. 16. Suddenly seized with sunstroke while harvesting. Insensibility; convulsions with clenched teeth; conjunctivæ injected, pupils contracted. *Treatment:* Venesection, after which the symptoms slowly abated. Recovery. (Pages 77, 78, 79.)

24. Med. Times and Gazette, May 27, 1871.—(*Dr. Gibson.*)—(*a.*) Male, æt. 17. Suddenly staggered and became insensible whilst walking in the sun. Pupils dilated. No vomiting. Abdomen hard. *Treatment:* Enemas, blisters, Croton oil, and salines. Recovered in six days. (Pages 77, 79.)

(*β.*) Male, æt. 17. Struck dead whilst haymaking in the sun. *Post-mortem:* Body very blanched and sphincters relaxed. (Pages 77, 80.)

25. New York Med. Journal, 1873, p. 93.—(*Dr. Katzenbach.*)—Details of cases of sunstroke. (Page 74.)

26. New York Med. Journal, 1872, Vol. XVI., p. 168.—(*Dr. A. Flint, jun.*)—Case of sunstroke. Profound coma. Temperature 110.5° F. Recovery. (Pages 77, 78.)

27. New York Med. Journal, Vol. X., p. 35.—(*Dr. Hewlett.*)—Male, æt. 30. Sunstroke. Delirium. Bled to 18 oz. Recovered without a bad symptom. (Pages 78, 79.)

28. American Journal of Med. Sciences, Jan., 1875.—(*Dr. Barnett.*)—Two cases of sunstroke treated successfully by hypodermic injections of atropia. (Page 80.)

29. India Med. Gazette, July 1, 1869.—(*Mr. W. K. Waller.*)—A series of cases of heat apoplexy treated by quinine. (Pages 78, 80.)

(*a.*) Male adult. Heat apoplexy. ℈j. of quinine given at once, and 10 grains repeated every hour. 70 grains given in all. Spoke after the second dose. Recovered in 13 days.

(*β.*) Male adult. Heat apoplexy. After 3 grains of quinine, the convulsions lessened in severity. After 30 grains the man became conscious. Recovery after 2 days.

[In these cases quinine was the only remedy used. A series of 31 cases of sunstroke recorded, 28 of which treated by quinine recovered.]

For other cases see same journal. Also "American Journal of Medical Sciences," Jan., 1870, p. 253, and "Indian Medical Gazette," Sept. 2, 1872 (*Mr. A. R. Hall*).

30. **Med. Press and Circular, Aug. 30, 1876.**—(*Dr. Winn.*)—Male adult. Case of sunstroke. Temperature, 112°. Death. (Page 77.)

31. **Medical Times and Gazette, March 16, 1878, p. 271.**—(*Dr. Handfield Jones.*)—Male, æt. 14. Sunstroke. Brief delirium at first, then unconsciousness, with stupor, prostration, and impaired mental actions. Motor and sensory paralysis of the left arm. Roseolous eruption. Frontal neuralgia. Temperature never very high. Stimulants were given, and the patient recovered by the 17th day. (Pages 77, 79.)

32. **British Med. Journal, July 9, 1870.**—(*Dr. Henry Thompson.*)—Sunstroke. Male, æt 59. Fell down unconscious. Left pupil contracted, and the right dilated. Temperature, 105° ; pulse, 130. Death in 1½ hour. Temp. rose to 107.2, after he had been dead 30 minutes. *Post-mortem:* Lungs engorged. Heart large, pale, flabby, and diseased. Arteries of brain atheromatous, and fluid found in the subarachnoid space. Blood everywhere fluid. (Pages 77, 80.)

33. **Lancet, Sept. 15, 1877, p. 415.**—(*Mr. Maurice Knox.*)—Male, æt. 26. (A soldier.) Heat apoplexy. Violent delirium. Temp., 105° F. Contracted pupils. *Treatment:* Cold douche and subcutaneous injection of quinine. Recovery. (Pages 78, 80.)

34. **Edinburgh Med. Journ., Oct., 1876.**—(*Mr. Thomson.*)—Male, æt. 36. Sunstroke, from exposure to sun for several days. The attack came on gradually. Semi-unconsciousness ; great thirst ; labored breathing. Lividity of face and contracted pupils. Diarrhœa and vomiting. Temp., 102°. Death occurred about 22 hours after "the fit." No *post-mortem.* (Pages 77, 78.)

35. **Lancet, July 29, 1876, p. 153.**—(*Dr. Shingleton Smith.*)—Two cases of sunstroke. (Temp. of day, 96° F. in shade.) (Pages 77, 80, 81.)

(*a.*) Male, 45. Had been working in the sun from 8 A.M. to 1 P.M. when he was attacked. Comatose ; pupils very contracted. Breathing labored. Active perspiration. Temperature reached 109° F. Iced water applied by Roberts's coils. Died at 7.50 P.M.

Post-mortem (17 hours after death) : Much p. m. lividity and numer-

ous petechial spots. Cerebral veins and sinuses full. The grey matter of the brain appeared of a dark purple color, the white matter exhibiting many bloody spots. Effusion into the ventricles and under the arachnoid. The blood everywhere fluid and dark, containing numerous air-bubbles from decomposition. The thoracic organs presented the appearance of death by asphyxia.

(β.) Male, æt. 35. When admitted was semi-comatose. General muscular tremor, followed by convulsions with opisthotonos. Temp., 110.2° F. Pulse small and rapid; respiration labored. Complete coma supervened, with contracted pupils. (Temp., 111° F.) Death in 20 minutes after admission. Five minutes after death the axillary temperature was 110.4°.

Post-mortem: Intense engorgement of the cerebral veins and sinuses, with subarachnoid effusion. Blood black and fluid. Symptoms of asphyxia not so well marked as in the former case. Death apparently resulted from cardiac paralysis.

36. Lancet, Aug. 26, 1871, p. 259.—(*Dr. Macdonald.*)

(a.) Male, æt. 63. Sunstroke. Became unconscious. He could not be roused. Breathing stertorous. Throbbing of carotids and temporals. Pupils contracted and insensible to light. Death in 1½ hour from commencement of the attack. *Treatment:* Bleeding, 12 ozs.; cold to the head; sinapisms to the extremities.

(β.) Male, æt. 34. Went into the sun after a full meal, at which he had drunk freely. Suddenly fell down insensible, but rallied in a few minutes, and recovered after a few days. (Pages 77, 79.)

37. Lancet, April 6, 1872, p. 464.—(*Mr. Clapham.*)—Sunstroke, commencing with drowsiness, pain in the limbs, followed by rigor, with faintness and nausea. Temp., 104.2°. Pain in the head, stomach, and back. Contracted pupils; injected conjunctivæ; great headache; pain down the spinal cord, branching off and encircling the body in two distinct lines, one following the course of the eighth intercostal nerves, and the other that of the first lumbar, ileo-inguinal, and hypogastric. Recovery after 8 days. (Pages 77, 78.)

38. Lancet, July 29, 1876, p. 154.—(*Dr. E. L. Fox.*)—Male, æt. 55. Suddenly seized as he was driving. Coma; tonic spasms of muscles of legs; pupils contracted but sensible to light; skin hot, with absence of perspiration; stertor. Temp., 106.4°; pulse, 141; respirations, 27. Temperature was reduced by the use of ice and cold water, and by quinine subcutaneously injected. Recovered consciousness the next day. Discharged cured on the third day. (Pages 77, 80.)

39. British Med. Journal, Aug. 3, 1872, p. 131.—Case of sunstroke where the temperature of the body exceeded 109° F. (Page 77.)

40. Lancet, Aug. 6, 1870, p. 183.—(*Dr. Andrew.*)—Male, 38. Exposure to sun without a cap for one hour. Felt giddiness and swimming in the head. This increased the next day, accompanied by a pain extending down the spine, which became so severe that he could not stand. Temperature, 100.6°. *Treatment:* Ice to the head and mustard plasters to the loins. He was better in 24 hours, and well after 4 days. (Pages 77, 78, 79.)

41. Lancet, Aug. 6, 1870, p. 184.—(*Dr. Harris.*)—Male, 3½. Slept in the sun until 4 P.M. *Symptoms:* Headache, short breathing (48), and bilious vomiting, which lasted all night. Became semi-comatose at 3 A.M. Pupils much and equally contracted. Temperature, 101.6°. Severe abdominal pains. Recovered on the eleventh day. *Treatment:* Salines, beef-tea, and no stimulants. (Pages 77, 78.)

42. Lancet, Aug. 6, 1870, p. 184.—(*Dr. Sieveking.*)—Male, 13. Heat apoplexy, followed by catalepsy. Temperature 100°; pulse 108. Face flushed; pupils dilated. The catalepsy set in on the fifth day. This passed away very slowly. Recovery. (Pages 77, 78, 79.)

43. Lancet, Aug. 27, 1870, p. 316.—Two deaths from exposure to the sun, one in five minutes, and a second after two hours. (Page 79.)

44. Medical Times and Gazette, May 12, 1877, p. 516.—(*Drs. Andrew and Dyce Duckworth.*)—Female, æt. 2½. All but universal paralysis, caused by exposure to the heat of the sun whilst travelling. No cerebral symptoms. Recovery. (Page 79.)

45. Lancet, Aug. 20, 1870.—(*Dr. Handfield Jones.*)—Some hours after exposure to the sun, sickness and vomiting set in, with impaired consciousness and loss of power. Conjunctivæ congested. The man was tolerably well the next day, and quite recovered after three or four days. (Page 77.)

46. Edinburgh Med. Journal, Vol. XVI., p. 780.—(*Dr. Thin*, of Shanghai.)—A series of cases of sunstroke. (Page 78.)

(*a.*) Male adult. Sudden seizure. Bled. Died within thirty minutes.

(*β.*) Male adult. Sudden insensibility; coma lasting for twelve hours. Bled; ice applied to head, hot water to feet, and brandy and water administered. Recovered, but was permanently paraplegic.

(γ.) Male adult. Sunstroke ; conscious, but great headache ; skin and head very hot. On the second day became delirious. Died on the third day.

(δ.) Male adult. Slight sunstroke, threatening organic mischief. Recovery.

(ε.) Male adult, a tea-taster. Sunstroke, but not from direct exposure to the sun. No head symptoms, but depressed action of the heart, with temporary suspension of the functions of the cerebellum.

(ζ.) Male adult. Symptoms resembled those of the first week of typhus. Recovered on the fifth day.

(η.) Male adult. Sunstroke, causing headache, debility, and loss of appetite. Recovered, but suffered for twelve months from disordered liver.

CHAPTER III.

BURNS AND SCALDS—CONSIDERED MEDICO-LEGALLY.

Definitions.—The General Characteristics of Burns resulting from Various Causes.—The Classification of Burns.—The Symptoms produced by Severe Burns, Local and General.—The Causes and Period of Death.—Post-mortem Appearances.—Appearances presented by Burns produced before and after Death.—Accidental, Suicidal, and Homicidal Burning.—Burns produced by Corrosives.

(Illustrative Cases, page 122.)

We shall consider the subject of burns and scalds in the following order:

1. The definition of burns and scalds.
2. How far is it possible to determine the origin of a burn by its appearance?
3. The classification of burns according to their intensity.
4. The symptoms and effects resulting from burns.
5. How far the period at which different burns were inflicted may be judged by their appearance.
6. The causes of death.
7. The period at which death ordinarily occurs.
8. The post-mortem appearances.
9. The means of distinguishing a burn inflicted during life from one produced after death, or from the effects of post-mortem change.
10. If the death was caused by a burn, was it accidental, suicidal, homicidal, or the result of spontaneous combustion?
11. The characteristics of burns produced by acids and other corrosive bodies.

1. *The Definition of a Burn.*

A *burn* is an injury to the body produced by the application of a flame, or of a substance heated above a certain temperature, or of radiant heat. (*Case* 1.)

A *scald* is an injury produced by the application of a liquid heated above a certain temperature.

For practical purposes it is unadvisable to draw any distinction, where in reality none exists, between burns and scalds.

Burns or scalds in law are not regarded as wounds, but in the statute on wounding they are included amongst bodily injuries dangerous to life. In some cases a prisoner guilty of inflicting a burn on his victim, might be prosecuted for "maiming." (*Case* 34.)

But the word *burn* has a wider signification than these definitions suggest. Thus *the injuries resulting from corrosive liquids*, such as oil of vitriol (sulphuric acid), aqua fortis (nitric acid), spirit of salt (hydrochloric acid), aqua regia (nitro-hydrochloric acid), caustic potash, lime or soda, carbolic acid, etc., are popularly termed *burns*, and are so designated in the statutes. In the case of R. *v.* Murrow (Liverpool, 1835) the judge decided that a burn caused by sulphuric acid, was not a wound within the meaning of the Act.

In the definitions of burns and scalds given above, no reference is made to the part of the body injured. An internal burn is as much a burn as an external one. Boiling water has been drank accidentally, and poured down the throat homicidally, causing an internal scald or burn. Melted pewter has been poured into the ear (*Cases* 27, 28), respecting which M. de Lowry remarks, that it is not easy to fill the ear with melted metal, owing to the expansion of the air in the meatus. Death in such case may result from inflammation extending to the brain.

Respecting the administration of corrosive liquids, it will be convenient to regard such internal burns as cases of poisoning.

2. *How far may the Appearance of a Burn enable us to Determine its Origin?*

(*a*.) *A heated solid* (such as hot iron) may produce a burn of any intensity, from mere skin redness to charring of the tissues, according to its temperature and the length of time it remains in contact with the person. In such cases the shape of the burn indicates somewhat the form, and the extent of the burn the size, of the heated solid.

In order to burn, some substances must be heated nearly to redness, or even beyond it.[1] Metals will produce redness, vesication, coagulation of blood, and other injuries when heated to 212° F. (100° C.). The *actual cautery* is said to be more efficacious in arresting hemorrhage at a black, than at a red or white heat.

Burns of greater intensity are produced by hot, semi-fused solids—which (either from their nature or from their being in a state of partial fusion) adhere to the skin, so that on removal either a portion of the cuticle is dragged away, or some of the hot material remains behind—than when (as in the case of a piece of hot iron) the source of heat can be instantly and completely got rid of, so soon as the pain renders the person conscious of actual contact with it.

It may not, perhaps, be out of place to mention here that the feats shown by workmen, and sometimes by public exhibitors, of handling red-hot metals, burning coals, and the like, are as a rule easy of explanation. "M. de Boutigny showed, at the meeting of the British Association at Ipswich, in 1851, that a hand which is naturally damp, or which has been slightly moistened, may be safely passed into a stream of *molten iron* as it flows from the furnace." (Carpenter's "Physiology," note to p. 484.) The ancient trial by the ordeal of the hot ploughshare may thus be explained, although it is to be feared that the more guilty the person, the more likely he was to escape. (See article on the Spheroidal State in the "*Popular Encyclopædia*.")

(β.) *Molten metals* cause burns (scalds) that can scarcely be distinguished from those produced by solid bodies. They may vary from a slight degree of skin redness, to an absolute destruction and charring of parts. Supposing the melted metal to be spilt on the skin, the burns will be found to be less regular in form than those produced by hot solids, and more often of greater severity, inasmuch as the metal to be molten must necessarily (in the majority of cases) be of a very high temperature. Further, the melted metal having once come into contact with the person, it is less easy for the patient to rid himself of it, than when he accidentally comes into collision with a heated solid.

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[1] Pouillet determined the following temperatures by means of an air thermometer. They correspond to the stages of incandescence of a metal bar:—

Incipient red heat	525° C. = 977° F.
Dull red	700° C. = 1292° F.
Cherry red	900° C. = 1652° F.
Dark orange	1100° C. = 2012° F.
White heat	1300° C. = 2372° F.
Dazzling white heat	1500° C. = 2732° F.

See article on Pyrometer in the "*Popular Encyclopædia.*"

Further than this, melted metals produce burns in all respects similar to those produced by solid bodies.

(γ.) *Boiling oils* produce burns as severe in their general characters and (so far as destruction of parts is concerned) in their effects, as hot solids or molten metals.

(δ.) *Boiling water.* The application of hot water may merely produce an inflammatory redness; but in severe scalds the skin commonly appears soddened, vesicated and of an ashy grey color, a condition scarcely distinguishable from slight burns resulting from other causes. But boiling water *never* produces (as in the case of hot solids or melted metals) blackening of the cuticle, much less charring or destruction of the parts. Hot-water scalds are frequently of considerable extent, and on this account are liable to prove rapidly fatal. (*Case* 6.) They may also be followed by gangrene. (*Cases* 26, 47.) Many cases are recorded where boiling water has been thrown over people for the purpose of maiming, but with no apparent intention of destroying life. (*Cases* 34, 35, 36.)

Cases are recorded where children, lunatics, and others have been scalded to death by being immersed in water at too high a temperature. (*Cases* 6, 6*a*, 6*b*.) This circumstance suggests the remark, that the use of the hand by a nurse in determining the temperature of a bath, instead of testing it by the thermometer, is culpable negligence. The hand is at best a fallacious test of temperature, its nerves, compared to parts not exposed, being slowly stimulated by heat. Again, the heat of the hand itself renders it an uncertain test;—thus a hand cooler than the liquid in which it is immersed, cools for an instant the water in immediate contact with the skin.

A remarkable case of boiling a child in water is recorded. (*Case* 37.)

Many cases are recorded where severe scalds of the mouth and glottis have resulted from a child putting its mouth to the spout of a kettle whilst steam was issuing therefrom. (*Cases* 44, 45.) In such cases false membranes frequently form from the extension of the inflammation; or it is not improbable that the fright may cause the child to make a deep inspiration whereby the steam or boiling water will be drawn into the back of the throat, and may possibly enter the larynx. ("*Brit. Med. Journ.*," May 1, 1875, p. 589.)

(ε.) *Phosphorus burns* are characterized by their great depth—by their severity, from the extreme heat accompanying the combustion of the phosphorus;—by their pain, the acid products of burning acting as violent irritants to the injured parts;—and, lastly, by the comparatively small extent of surface commonly destroyed. As a fact it will

usually be found that the part affected is limited to the actual spot on which the phosphorus burns, the phosphoric acid generated during combustion coating the surrounding skin, and acting like a varnish to prevent the spread of the flame.

(ζ.) *Gunpowder burns* are often of great superficial extent, and for that reason not infrequently fatal. They are usually marked by extensive scorching, from the globe of flame produced. Numerous carbon particles are commonly found embedded in the true skin of the part burnt, which on recovery leave permanent tattoo marks of a more or less violet-black tint. It will be noted that in gunpowder burns these spots of color are of very uniform size.

Our remarks here do not refer to injuries resulting from the firing of gunpowder in a pistol, so much as to explosions of free powder. When a pistol, loaded with gunpowder only, is fired near the naked skin, penetrating wounds (as if caused by bullets) are frequently produced. These are due to unburnt particles of powder playing the part of small shot. Under these circumstances, in addition to the scorching effects of the powder, contusions and lacerations of the skin may occur. These will be more fully discussed under gunshot wounds.

(η.) *Petroleum burns* (or burns resulting from *rock oil*, *paraffin*, etc.,) are generally severe. One cause of this is that the fibres of the clothes, on which the spirit is commonly spilt in such accidents, act as wicks to assist combustion. In these cases, the powerful odor of the liquid is certain to be detected for some days after the accident has happened, whilst the parts scorched, and the surrounding skin, are usually much blackened from the carbonaceous matter set free during combustion. (*Case* 33.)

(θ.) *Burns from flame* are characterized by extensive scorching. Scorched hairs in the neighborhood of the parts burnt, although not actually on the injured part, are very suggestive of flame as the origin of the burn. Scorched hairs are scarcely likely to result from the application merely of a hot body, and certainly could not be produced by boiling water, or even by boiling oils.

(ι.) *Burns from explosions of fire damp in coal mines* are frequently of great extent, and present the appearance of great scorching. Very frequently a quantity of coal dust will be found embedded in the true skin. This may give the burn the appearance of having been produced by a gunpowder explosion. In one case, a doubt of this kind formed the ground-work of a legal action (Norfa Colliery Explosion Case, March, 1870). The tattoo marks resulting from coal dust, however, are commonly of a blacker color than the marks

produced by gunpowder, whilst the spots are far less uniform in size.

(κ.) *Burns from acids, etc.* These will be described in detail under the various reagents. A sulphuric acid stain is brown, and a nitric or hydrochloric acid stain yellow. The scars are soft and not hard as in ordinary burns. The skin sloughs away, leaving a granulating surface. Such burns are not surrounded (as in the case of those produced by heat) by reddened skin.

3. *The Classification of Burns.*

Dupuytren has classified burns, according to the amount of injury inflicted, in six degrees, as follows:—

1*st Degree. The skin only is scorched, or slightly reddened, with efflorescence of the cuticle, but without permanent injury.*

This state would be produced by the momentary contact of a hot body, or by water some degrees below boiling point. It leaves no mark after a few hours, but causes pain at the time.

2*d Degree. The skin exhibits general redness, and the formation of vesicles, either at once or after a few hours.* Some of these vesicles or blisters may be very large and tense with serum.

The second degree implies a longer contact of heated solids or of liquids at the boiling point, than the first degree. [Iodine, cantharides, strong acids, melted sealing-wax, tallow, metals heated to 212° F. (100° C.), etc., produce very similar vesication.] Although there may be some suppuration of the vesicles, burns of the second degree seldom leave permanent marks, except in persons of a bad constitution, or in those weakened by previous disease. These burns invariably cause considerable pain.

3*d Degree. The cutis or true skin is destroyed; yellowish grey or brown eschars form, which involve the whole thickness of the skin. The surrounding integument is more or less reddened and vesicated, and the parts affected are extremely painful.*

In this third degree, a mark of a shining white cicatrix without contraction of the neighboring parts remains. Occasionally the cicatrix itself contracts considerably, assuming a *cheloid* condition.

4*th Degree. In this the whole thickness of the skin, and part of*

the subcutaneous cellular tissue are destroyed. Dry, yellowish black, insensible eschars are formed, with considerable inflammation around, leaving on their separation deep and luxuriantly granulating ulcerated surfaces.

5*th Degree. In this the eschars extend more deeply, the muscles, fasciæ, and soft structures being implicated.*

In the fourth and fifth degrees not only are cicatrices formed on recovery, but considerable deformity generally results from the contraction of the skin and of the deeper tissues. Thus the head may be drawn down to one side, unless great care be taken during the healing process; and even with every care, skill, and attention, it is not always possible to prevent deformity. The arm or leg also may be contracted into a bent and almost useless position, or the fingers be tied down or united together by webs of skin. Very often limbs have to be amputated, in whole or in part, on account of the destruction of the skin being too great to allow of repair, or even of a plastic operation.

6*th Degree. In this an entire limb, bones and all, may be destroyed and charred.*

It seldom happens, but that in a burn two, three, or more of these six degrees will be found mixed together. (*Case* 20 β.) Hence Mr. Luke, Mr. Curling, and other surgeons have suggested a simpler classification of burns, as follows:—

(*a*.) Burns only involving the skin or subcutaneous connective tissue.

(β.) Burns involving the muscles and tendons, with their nerves and blood-vessels.

(γ.) Burns involving the bones or internal viscera.

(δ.) Mixed burns, in which the three preceding varieties are more or less combined.

4. *The Effects produced by Burns.*

These effects we may consider under the two heads of local and constitutional:—

(*a*.) *Local Effects.*—Redness, vesications (entire or burst), destruction of cuticle, either alone, or involving the true skin (*cutis vera*),

actual roasting or carbonization of parts for a greater or less depth, marks of blackening, burning of the hair, etc., are some of the local results of burns of different degrees. Further, it is not uncommon to find on a single body all degrees of intensity, from redness to charring. (*Case* 20 β.)

Omitting cases of carbonization, we note that the skin redness produced by a burn differs greatly in its appearance on such causes as the intensity of the heat, time of exposure, etc. Thus the cuticle may be merely reddened, or dry and parchmenty. The reddening may go deeper and affect the true skin, giving it a dotted appearance, the dots corresponding to the openings of the sudoriferous and sebaceous ducts. If the burn be severe, it may perhaps implicate the subcutaneous tissues. Here and there, entire blisters will probably be found, containing a thick and highly albuminous serum; whilst in all probability there will be some burst blisters, the serum oozing out of fissures or apertures in the cuticle and drying on the parts around. The redness above described, it must be remembered, results whenever the skin is inflamed, whether by disease, friction, strong stimulants, or heat.

Before very long the cuticle will in parts assume an ashy grey color, or even an appearance of extreme whiteness. In many cases, almost immediately after the burn has been inflicted, a deeply injected line of demarcation will be apparent between the parts burnt and the sound skin. The value of this line medico-legally, we shall discuss at some length when we consider the methods of distinguishing burns caused during life from those produced after death. In a case of a severe burn arising from hot water, the nails of the fingers and toes were said to have been detached; at any rate they were found wanting at the post-mortem. (*Case* 6.)

Experience proves that the danger of a burn depends less on its depth, than upon its extent. A roasted limb is not so dangerous to life as a less severe burn affecting two-thirds of the skin. In other words, the prognosis will be unfavorable in proportion to the number of square inches of surface involved. The explanation of this will be found, partly in the greater implication of sensory nerves in extensive burns, and partly on the fact that so much of the skin is prevented from doing its work of excretion and heat regulation. Thus, if we simply varnish any considerable portion of the skin of an animal with an impermeable material (like gutta-percha or india-rubber), it becomes greatly inconvenienced, whilst if some three-fourths or more of the body be thus treated, the animal usually dies.

It is a question of considerable importance medico-legally, what

extent of skin must be injured necessarily to prove fatal. In a case involving one-fifth of the body the patient seems to have recovered. (*Case* 13.) A burn involving two thirds (*Case* 6), and even one-half of the entire skin, we may regard as certain to destroy life, and the same practically may be said of a burn (if severe) involving one-third of the body. But when we come to smaller areas, there are many circumstances that must be borne in mind, and which need scarcely enter into our consideration when we are dealing with burns of greater extent. For instance (a), the *constitution and pain-bearing power of the patient.* Thus considering the dangerous effects of pain, and the very different powers possessed by different persons to bear it, there will necessarily be a great difference in the result of a burn occurring on a robust, powerful man, and one of similar extent affecting a highly nervous, sensitive woman. Again (β), the *part affected* must be considered. Thus burns on the extremities are less fatal than those on the trunk, whilst burns on the perinæum, or upon the labia in the female or the scrotum in the male, are more than ordinarily dangerous. Again (γ), the *character of the burn* (*i.e.*, whether it be continuous or in numerous small patches) is of importance. Given two burns, both of equal extent, the one being continuous and limited to one part only of the body, and the other occurring in isolated and divided patches, more or less spread over the whole body, the latter undoubtedly is the more dangerous, not only because the pain and vascular reaction will be greater, but because it is more difficult for the patient to rest (and for recovery in such cases, sleep is no unimportant consideration), and also more difficult for those in attendance to insure the efficient application of necessary dressings to the injured parts. And lastly (δ), *the age of the patient* is an important element, children as a rule bearing burns badly, whilst old people bear them comparatively well.

The fact that the danger of a burn is in proportion to its extent, or as we may say according to the "law of square inches," is strikingly shown by a series of cases of burns resulting from gunpowder and steam, recorded by Inspector-General Dr. William Smart, of Haslar Hospital, and founded on his experience in the explosion on board H.M.S. "Thunderer." ("*British Medical Journal*," Sept. 23, 1876, p. 389.) In the majority of the cases, from 200 to 500 square inches of surface were injured. One man, who had some 766 square inches of skin (or nearly one-third of his entire superficies) burnt, recovered. His scald was, however, only one of the first degree. A scientific observer, who has witnessed two great magazine explosions, remarks that if as much as 80 square inches of skin be damaged, there is always a

degree of secondary fever involving danger to life. Dr. Smart considers that a burn involving 350 square inches, places life in the greatest jeopardy—gunpowder burns being more hazardous than those caused by steam.

Amongst the occasional effects of fire on the body, is the formation of extensive fissures in the skin, that assume the character of *wounds* of greater or less extent. These are no doubt occasioned by the destruction of the elasticity of the skin as a primary consequence of the extreme heat to which it is subjected, and, as a result, its giving way or splitting under the patient's struggles. Hence, as a rule, these wounds will be found in the neighborhood of joints. (See *Cases* 23 and 24.) In most cases they are exceedingly irregular in form, with uneven and jagged edges. Sometimes, moreover, the layer of fatty tissue adherent to the skin will give way at the same time as the skin, whilst at other times the skin only will be found fissured. The blood-vessels, owing to their greater elasticity, may escape being torn, and be found stretching across the fissured tissues. In all cases where we are called upon to inspect a body burnt to death, having wounds upon it, these vessels stretching across the wounds should be carefully sought for with a powerful hand lens.

It is manifest that if wounds are found on the body of a person supposed to have been burnt to death, the following question is one of primary importance for the medical jurist to decide, viz.:—Were the wounds the result of violence inflicted by some cutting instrument *before* the burn, or were they the result of the burn? Given the absence of any marked effusion of blood in the exposed adipose tissue—given, further, an *irregularly* fissured wound with uneven edges, more especially if in certain spots unbroken blood-vessels be found stretching across the fissured part, such characteristics would lead us to infer that the wound was the result of the burn, and not caused by an instrument of violence.

There is a still more marked characteristic of these wounds to be occasionally noted, and that is where the skin has fissured, and the melted fat run out of the wound and varnished the parts around the fissure. (See *Case* 24.)

As a rule these heat wounds are of no great depth, but in certain recorded cases they have been so deep that the contents of the thoracic and abdominal cavities have been exposed. (*Case* 8.)

It must of course not be forgotten that on a burnt body, wounds of previous violence may exist cotemporaneously with wounds the result of the fire. Hence the appearance, the shape, and the general conditions of each and all the wounds found on a body should be ac-

curately noted and described. The following headings for the description of such wounds may be useful :—

(1.) Their position (*i.e.*, whether near a joint or otherwise).
(2.) Their characteristics (*i.e.*, whether regular or irregular, jagged or otherwise).
(3.) Their depth in different parts.
(4.) The character of their edges (*i.e.*, whether even or uneven, smooth or otherwise).
(5.) Whether there be any effusion of blood in the adipose or other tissues exposed.
(6.) Whether blood-vessels are, or are not, to be observed stretching across them.
(7.) Whether there is any appearance of melted fat having poured out through the wound.

Lastly, it will probably be noted that in certain parts of the body, the skin, although perhaps not actually fissured, will be in such a condition of tenseness that but a very slight movement would tear and lacerate it.

(β.) *Constitutional* (or general) *Effects.*—The first important constitutional effect to be noted as the result of a burn, is *great collapse* or *severe shock to the nervous system.* The surface of the body becomes pale, the extremities cold, and the pulse quick and feeble. There will be repeated and severe rigors or shiverings, and the patient will complain bitterly of being cold, the thermometer all the while indicating a febrile temperature. In some cases, however, the temperature is really sub-normal, as in collapse proper. In fatal cases, these symptoms are rapidly succeeded by laborious breathing, coma, convulsions (particularly in young children) and death ; whilst in others, dissolution is preceded by a period of imperfect reaction, accompanied by delirium and a sharp jerking pulse. Mr. Erichsen states, that the first period of depression and congestion occupies, as a rule, some forty-eight hours. Before reaction sets in, there is usually an interval of quiet, during which the sufferer may die comatose from congestion of the brain and its membranes, and from effusion into the ventricles. Death sometimes occurs from a sort of passive œdema or dropsy of the lungs, and more rarely the serous cavities become the seat of copious and fatal effusion.

From the second day to the second week is the period of reaction and inflammation. *Irritative fever* attended with thoracic complications, such as *pneumonia*, *pleurisy*, or *bronchitis*, or a compound of all

three, may set in. Enteritis, with ulceration of the bowels and consequent peritonitis may, and as Mr. Curling[1] has pointed out, not unfrequently does, occur.

We have next to consider the *stupor* or *coma* produced by burns and scalds. This has often been mistaken for *opium-poisoning.* As a fact, there are no well-marked indications by which to distinguish the coma of the one from the coma of the other. Mr. Abernethy once gave evidence in a case where a surgeon was charged with the manslaughter of a child by opium, the comatose condition in which it died being ascribed to two doses of eight and ten drops of laudanum given to relieve the pain of a severe scald. The surgeon was acquitted, Mr. Abernethy deposing, not only that the practice of giving opium in such cases was usual, but that the coma was in all probability the result of the burn and not of the opium. The author cannot concur in Dr. Taylor's recommendation to withhold opium from burnt children. *It must not be forgotten that extreme pain may be, and often is, fatal.*

Tetanus may supervene on *burns and scalds.* (*Cases* 2, 7.)

5. *The Period at which different Burns were Inflicted.*

When there are *several burns* on a dead body the question may be asked, "*Were all these burns inflicted at one and the same time?*" To answer this, note must be taken whether any of them have begun to suppurate, or slough, or cicatrize, or show any other changes indicative of vital action. Nevertheless it must be remembered that burns inflicted at the same time may not heal with the same rapidity, owing either to differences of degree, or to some peculiarities of circulation or innervation, or to their situation.

6. *The Causes of Death.*

The causes of death from burns are various. ("*Vierteljahrss.*," 1870, II., 93.)

(*a.*) *Injury.*—In the case of fire attacking buildings, etc., instances of instantaneous death may result from the fall of bricks, timber, etc. Or, again, in the endeavor to escape, people may fall from windows or

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[1] "Medico-Chirurgical Transactions," Vol. XXV.; Humphrey, "Association Journal," Oct. 19, 1855.

roofs, and thus meet with fatal injuries. These accidents may cause death after a longer or shorter interval.

(β.) *Syncope* and *Suffocation* (asphyxia).—There is little doubt that in large fires, suffocation resulting either from the actual want of fresh air, or from the presence of a large excess of the products of combustion (CO_2, CO), or both, is frequently a cause of death.

In *Case* 1 the question arose whether the cause of death was suffocation, or the effects produced by the burns. The burns found on the body Dr. Bonfanti attributed to *radiant heat.* Experiments were tried with radiant heat on amputated limbs, but the results obtained were not satisfactory, living skin being affected far more readily by heat than dead. Undoubtedly injuries similar to those arising from the direct application of heat to the skin, may result from radiant heat of sufficient intensity. But in the case quoted the difficulty appears to have been to explain why the back and front of the body should exhibit the presence of burns, whilst the clothes covering the body were uninjured.

(γ.) *Collapse*—in other words, an absence of rallying power from a severe *shock to the nervous system.* This great depression of nervous force is perhaps the chief cause of danger in cases of burns. Collapse is most likely to kill in the case of extensive burns on the trunk.

(δ.) *Coma, Convulsions, Tetanus, etc.*, or other symptoms referable to the brain and nervous system. (*Case* 2.)

(ε.) *Bronchitis, Pneumonia, Œdema of Lungs*, or other thoracic complications.

(ζ.) *Enteritis*, ending in *peritonitis or hæmorrhage*, due to abdominal lesions.

(η.) *Exhaustion*, arising from pain, or from profuse or long-continued suppuration. ("*Lancet*," Feb. 19, 1870, p. 267.)

(θ.) *Gangrene, Erysipelas, Pyæmia, etc.* (*Case* 47.)

(ι.) Lastly, death may result, after an interval more or less remote, from secondary causes, as in *Case* 3, where death occurred after three months from ulceration of the bowels.

This circumstance suggests the general remark that the cutaneous and visceral nerves of the body are closely related. Thus may be explained the visceral inflammations so often occurring in cases of burns during the stage of reaction. It is in this way that the severe effects of the primary shock are chiefly produced. The later pulmonary inflammation is probably due to the reflected influence through the pneumogastric on the lungs. Hence any previous nervous depression must intensify not only the sequelæ of, but also the shock arising from, a burn.

7. *The Period at which Death occurs.*

There can be no question that the first week after a burn is the most fatal period. Thus of fifty fatal cases of burns noted by Mr. Erichsen, there died—

During the first four days	27	cases.
From the fourth to the eighth day	6	"
In the second week	8	"
" third "	2	"
" fourth "	2	"
" fifth "	4	"
" sixth "	1	case.

Death, however, may be delayed for a considerable period. Thus in one case of burns (*Case* 3) resulting from a coal mine explosion, death occurred from ulceration of the bowels three months after the accident. Or, again, a person may recover the primary effects of a burn, and die after an interval, longer or shorter, from exhaustion or other causes. (*Case* 2.) As a fact, inflammation of the viscera, which not unfrequently is the cause of death in the case of a severe burn, does not set in for several days after the accident, during which interval a considerable alleviation of the extreme pain may occur, and consequently an appearance of partial recovery.

And here a further medico-legal question may arise—*How long after a burn did the person live?*

Death may be almost instantaneous from shock, or exceedingly rapid from the effects of the gases of combustion. So rapid, indeed, may the fatal result be, that the time is insufficient for even inflammation of parts to set in, the post-mortem revealing no well-marked signs of the accident, nor any visceral abnormalities to indicate the actual cause of death. The existence of suppuration, much more of gangrene, proves that the person must have lived for some time (say 48 hours at least) after the burn had been inflicted, although on these points it is impossible to lay down definite rules.

8. *The Post-mortem Appearances produced by Burns.*

Supposing a body to be more or less completely charred, it may still be possible to distinguish the sex from the pelvis, and the age from the length and character of the bones, or if the person be very

old, from the jaw. In such investigations, moreover, the finding remains of rings and studs, or of false teeth, or the gold mounts of teeth, may constitute most important evidence of identity. (See Dr. Parkman's case, Vol. I., p. 230.)

Even should the body be reduced to ashes, it is not improbable that the bones may retain their form and shape sufficiently, at any rate, to enable us to determine certain of their characteristics. Of course, the presence of foreign bodies amongst the ashes, as in the former case, must be carefully sought for. For a body to be reduced to ashes (remembering that the human body contains 75 per cent. of water), a great heat long applied is required. Admitting that there are exceptional cases where a body has been reduced to ashes (such as, *e.g.*, the case of Mr. Scott, which occurred in London in the great fire of 1861, when only two or three bones and a gold watch and guard marked the spot of his death), it is certain that as a rule a body subjected to great heat will merely be carbonized, the skeleton remaining more or less complete, with remains of the soft parts upon it sufficient to establish identity. (*Case* 25.) In Mr. Scott's case the body had been subjected to a white heat for ten or twelve days, a condition only likely to occur exceptionally.

But it must be remembered that death may occur in, and from a fire, and yet no external appearances be apparent, as when, for example, it results from suffocation. It is difficult I admit to see how a body could escape burns of greater or less degree, either before or after death, in such case; nevertheless the possibility of death occurring from suffocation, and under such conditions that the skin might suffer no injury indicative of a burn, is manifest. Under these circumstances we should probably find marked suffusion of the eyes, whilst the internal appearances would be certain to yield important evidence. Thus in *Case* 19, where two children met their death in a fire, severe burns were found on one child, whilst on the other no burn marks were visible at all. Nevertheless, at the post-mortem, indications of death by asphyxia were discovered in both cases.

It is most important that we should carefully examine the body for all fractures and wounds, and if present, as far as possible determine their cause. (*Case* 38.) The possibility of wounds in such cases resulting from pieces of timber, etc., accidently falling on the person must not be overlooked.

Again, if the bones be reduced to ashes, the presence of phosphate of lime in the burnt residue in quantity, will be strongly indicative of animal remains.

In all the cases thus far mentioned, the chemical analysis of resi-

dues may furnish important evidence. It is quite true that organic and volatile poisons would be destroyed by the heat, but there are other poisons that would not be similarly affected; and if any suspicion of death from poisoning exists, the analysis of the ashes may serve to prove or disprove its truth, so far as certain indestructible poisons are concerned.

Supposing the body to be charred or roasted, it will probably be quite impossible to form any opinion as to previous acts of violence on the person, or whether death was caused by violence or by fire. Cremation of a body has not infrequently been adopted to cover crime. (*Case* 17, 20 *a*.)

We now leave the examination of charred and incinerated remains, to consider the post-mortem appearances presented in an ordinary case of death from burning:—

(*a*.) *External Appearances.*—The post-mortem appearances of a burn on the dead body, will resemble for the most part those already described as the appearances found during life, viz., a reddened or ashy white or parchmenty state of skin, and a blistered cuticle. The resulting vesications may be either entire or burst, the exuded serum in the latter case having coated the skin with a kind of albuminous varnish. The parts where the burnt and unburnt tissues join, will be indicated as in life by a red line of demarcation; whilst under the raised cuticle the true skin will appear of a brownish red color. (*Cases* 6 and 24.)

If a patient has lived for some time after a severe burn, suppurating surfaces and granulating sores will probably be found. (*Case* 4.) It is evident that the exact appearance will depend on various circumstances, such as the intensity of the heat, the length of time the patient has lived, and the vital power of the constitution.

In one case of death from scalds, it is stated that the nails of the fingers and toes were found wanting. (*Case* 6.)

In examining and reporting on a burn we must carefully note the following details:—

(1.) The part or parts of the body burnt.

(2.) The special characteristics of the burnt portion (whether charred, vesicated, merely reddened, etc.).

(3.) The extent (stated in square inches) of the burn.

(4.) Whether there is any well-marked and deeply injected line, dividing the injured from the uninjured tissues.

(5.) Whether the blisters are full of air or of serum. If they contain serum, it should be noted whether it be watery or thick.

(6.) Whether the true skin, after the cuticle is removed, exhibits a dotted injected appearance.

(β.) *Internal Appearances.*—Cases of death from burns not infrequently occur where no internal post-mortem appearances can be detected. (*Cases* 5 and 7.)

Case 7 is remarkable, inasmuch as tetanic stiffness occurred before death, and yet no signs of lesions were noted at the post-mortem either in the brain or spinal cord, or indeed of any abnormalities in other parts or viscera.

If death results from shock, or from the simple exhaustion occasioned by pain, it is probable, at any rate possible, that no post-mortem appearances would be discovered.

Inflammation of Serous Membranes with Abnormal Effusion into Serous Cavities.—Thus after deaths from burns, fluid in more than usual quantity will frequently be found in the ventricles and at the base of the brain; also signs of pleurisy with pleuritic effusion (*Case* 4); effusion into the pericardium (*Case* 4), abdominal cavity, etc. No doubt effusion is in such cases the result of a sudden reflux of blood resulting from the injury.

Congestion of the Mucous Membranes of the Bronchial Tubes and Alimentary Canal.—The bronchial tubes, as well as the lungs generally, even when death occurs at a very early period, are usually congested. (*Cases* 9, 17 and 19.) In death resulting from suffocation in a large conflagration, a sooty, frothy mucus is usually found in the larynx and trachea. (*Cases* 19 and 26.) Sometimes, however, the respiratory tract has been found normal. (*Case* 11.) In *Case* 26 the lungs were said to be pale and anæmic.

Congestion of the stomach and of the alimentary canal, more especially of the œsophagus, duodenum, and ileum, are generally well-marked post-mortem signs of death from burns. The parts are variously described as rosy red, scarlet, etc. (*Cases* 14 and 19.)

The author from a personal examination of many fatal cases of burns, can confirm Mr. Curling's statement that *perforating ulcers of the duodenum* are common, particularly in children and young people, in whom Brunner's glands are very active. These ulcers are rarely found before the sixth day, the second week being the usual period of their occurrence. Mr. Murray Humphrey has observed that the lower part of the œsophagus is sometimes ulcerated, and the author has noted that Peyer's patches, and in fact the solitary glands generally,

are often greatly inflamed and sometimes ulcerated in injuries to the skin resulting from severe burns, scalds, large blisters from the Spanish fly, and the burns inflicted by strong carbolic acid. Intussusception of the small intestines is also very commonly noted after death from burns, but is probably only a phenomenon attending the death. The ulcers described may set up peritonitis, or fatal hemorrhage, by implicating a large artery. In this way blood may be vomited or passed by stool.

The *heart* is sometimes found empty (see *Case* 17), but more often the right side of the heart is full, and the left empty. (*Cases* 4, 6, 11, 19.) The larger blood-vessels have frequently been recorded as congested, whilst the rest of the body was anæmic. (*Cases* 4 and 10.) These appearances are not unlike what we should expect as the result of death by asphyxia.

The *brain* has been frequently observed congested with red blood. (*Cases* 6, 9, 16, 19.)

The *liver*, *kidneys*, and *pelvic organs* are not unfrequently congested. (*Cases* 19 and 26.) In *Case* 19, where two children were exposed to the same fire, the liver and kidney of one child were congested, whilst in the other they were normal.

The *color of the blood* varies. In Dr. Buzzard's cases there was no venous blood in the body. (*Case* 16.) It is evident if death result from asphyxia due to an excess of *carbonic anhydride* and a want of oxygen in the air, the blood will be dark colored (venous) (*Cases* 6 and 19); but if death is occasioned by breathing *carbonic oxide*, which under certain circumstances may be the chief product of combustion, the blood will then be found of a bright red color (carbonic oxide hæmoglobin). (*Cases* 4 and 16.)

9. *The means of Distinguishing Burns inflicted during Life from those produced after Death, or from the Effects of Post-mortem Changes.* (*Cases* 1, 20 *a*, 20 *β*.)

On this matter two points are certain and may be disposed of at once:—

First. If a body be found completely charred or roasted, it will be impossible to say whether the *primary* application of the fire was to a living or to a dead body, seeing that a living body cannot be charred. In other words, the roasting (much more the charring) process would not commence until after the death of the person, even supposing him

to have been alive when the fire was first applied. Hence no opinion can be offered from an inspection of charred or roasted remains as to the life or the death of the individual before the action of the fire.

Secondly. If the presence of granulations are well marked on a burn, more especially if "proud flesh" [*i.e.*, exuberant granulations] is apparent, or if pus or gangrene or the like are found on the burnt portions, we may regard the indications afforded by these (being essentially vital phenomena) as proof positive that the sufferer lived for some time after the burn had been inflicted.

There are two specially marked characteristics of burns, produced during life (*i.e.*, where destruction of tissue has not resulted), and to these our attention must be directed in some detail, viz., (a) a red line dividing the injured from the uninjured skin; and (β) the formation of blisters (vesication).

(a.) *Line of redness.*

On applying a hot body to the skin of a living person, the part to which the heated substance is actually applied will at once (as we have pointed out) assume a coppery red color, the skin becoming dry and parchmenty, and the cuticle after a time rising in a blister. And here, in passing, we may note that the dry and parchmenty condition of skin found in a burn, at once serves to distinguish it from a post-mortem appearance (*i.e.*, from the result of decomposition), where the cuticle, at any rate for a considerable period after death, is moist and the reverse of parchmenty. Around this coppery-colored blush, or the blister if such be formed, the skin has a dead white or grey appearance. Surrounding the dead-white skin we shall observe the *line of redness*, of varying depth and width according to the intensity of the heat, and the length of time the hot body was applied. This line of redness shades off on the outer side to a diffused blush, which may extend some distance. This diffused redness, however, is not to be confounded with the line of redness. The diffused redness is nothing more than a mere capillary congestion or erythematous blush removable by pressure with the finger, and disappearing after death. The line of redness, on the contrary, is (like that seen in gangrene) a true line of demarcation between living and dead tissues—the result of vital reaction, appearing almost immediately in many cases after the infliction of the burn, not materially affected by pressure, and not disappearing with death. The medico-legal importance, therefore, of this line of redness depends (1) on its almost certain formation when burns are inflicted during life; and (2) on its permanence after death.

But it is necessary to consider here the indications afforded by its absence and by its presence in greater detail :—

(i.) Given *the absence* of the line of redness, are we justified in stating positively that the burn *was not* inflicted during life? The existence of the red line being the result of vital reaction (*Ann. d'Hyg.*, I., p. 442), it must be admitted that there are cases of severe burns (and more than one is known to the author), occurring on persons of a low degree of vitality, where the line is at best but very slight, or where it has been very slow in making its appearance. (*Case* 15.) Considering, therefore, *first*, that this red line depends on a reaction (and there may be none, or next to none); and *secondly*, that it requires a certain time (rapid as its formation usually is) for its appearance (whereas a severe burn may destroy life almost instantly), we should scarcely be justified in saying that the *absence* of the line of redness is positive proof (however strong an indication it may be) that the burn was not inflicted during life.

(ii.) Given *the presence* of the line of redness, are we justified in stating positively that the burn *was* inflicted during life? Allowing that the formation of the line of redness is the result of vital action, it may be conceded that it cannot be produced on, or in, tissues that are dead. But it is equally certain that the molecular death of the tissues or of particular parts of the organism, may be delayed for a longer or shorter time after what is termed somatic death—that is, the general death of the body (Vol. I., p. 24). Hence the line of redness may be formed on a part, and in tissues, where there still lingers a certain degree of vitality, although we should be justified in considering the person to be actually dead. I have myself produced this line of redness, more or less well marked, by the application of a hot iron, in several limbs, within five minutes of amputation; but I have never succeeded in producing it either on limbs or bodies at a period later than five minutes after amputation or death. Sir R. Christison ("*Edin. Med. and Surg. Journ.*," XXXV., p. 320) gives ten minutes as the period after death beyond which he was unable to obtain this red line. Dr. Taylor failed to obtain it in bodies that had been dead some hours. Chambert ("*Ann. d'Hyg.*," 1859, I., 368) believes the red line to be practically distinctive of a life burn. On the other hand, Champouillon ("*Ann. d'Hyg.*," 1846, I., 421) asserts that a red line always accompanies heat blisters produced after death in dropsical subjects. I have myself observed the red line to which Champouillon refers, but it is of so slight a nature and so superficial (so entirely different indeed from what we are describing) that I can scarcely think it could be mistaken for the deeply injected deep red line of a burn produced during life.

The conclusion, it seems to me, therefore, that we are justified in drawing respecting this red line of demarcation between living and dead tissue (for that really is what it is), is that although its absence may not be absolute proof that a burn was not inflicted during life, nor its presence that it was, nevertheless that it constitutes the strongest possible presumptive evidence as to the period when the burn occurred; its presence undoubtedly indicating, even supposing the burn was not inflicted during bodily life, that it was inflicted at most within a few minutes of that bodily life, and at any rate during the molecular life of the part or of the tissue concerned.

Lastly, we may note that if in the course of this line of redness, minute pus-yielding granulations are to be seen (a hand-glass being often necessary for their detection), we should then have no hesitation in asserting positively that the burn was produced during the bodily life of the person, seeing that at least some hours are necessary for the production of pus-yielding granulations.

(β.) *Vesication.*—By a blister we understand the exudation of the serum of the blood from the surface of the true skin and its collection between the cuticle and the true skin (*cutis vera*).

It is evident that the exudation of a fluid on the one hand, and the continuity of the cuticle on the other, are the two essential conditions for the production of a true blister.

When intensely heated solids have been applied, with the effect of producing actual destruction of the skin, although there can be no vesication at the precise spot, nevertheless, on parts contiguous, and to which the heat may have extended by radiation, vesicles may form.

Again, vesicles are certain to be produced in the case of burns resulting from boiling water, melted sealing-wax, etc., or indeed any agency where the heat is insufficient to effect a destruction of skin.

The formation of a true serous blister indicates as a rule that the burn was inflicted during life. Thus, the action of heat on the skin has been suggested as one of the minor signs of death (Vol. I., p. 33). The action resulting in serous exudation must be regarded as vital. But here, again, we must distinguish between the life of the body as a whole, and the life of its separate tissues and portions.

We must now consider the medico-legal value of vesication in greater detail:—

(i.) Given *the absence of blisters* (supposing the cuticle to be continuous), are we justified in assuming positively that the burn was not inflicted during life?

Most certainly not. Sometimes no vesicles whatsoever form after

a burn. Or, again, admitting that in certain cases vesicles form almost immediately after the infliction of a burn on a living body, it is equally certain that in other cases many minutes and even hours may elapse before the blister rises. (*Case* 15.) In this interval the patient may die, under which circumstances the blister will not rise. Further, it has been shown by M. Bouchut (see Chaubert's Papers in the "*Ann. d'Hygiène*," April, 1859), that the application of heat to the skin of a patient dying from phthisis produced no blisters, nor indeed any other effect than its application would to a corpse.

Some little care is necessary to decide positively in any case the absence of vesication. A mere pin-hole aperture in the cuticle would be sufficient to allow the serum, which would otherwise collect and form a blister, to escape, and so prevent a vesication being formed. This has been noticed many times in our experience. It suggests the necessity, in cases where a question of this kind occurs, of carefully examining the cuticle with a lens for minute apertures, or for what very frequently may be noted, minute fissures. The non-elasticity, the parchmenty and unyielding condition of the cuticle resulting from a burn, is very liable to force out the serum as fast as formed, if but the slightest outlet exists.

(ii.) Given *the presence* of blisters on a burnt body, are we justified in assuming positively that the burn was inflicted during life?

In all cases where questions of this kind occur, the character of the blister and the nature of the red line surrounding it, are (as we have already indicated) most important details. We limit ourselves now, however, to the blister itself, and not to its anatomical characters.

In considering the conclusions to be drawn from the presence of blisters, it will be well to study the experiments that have been recorded, and the conclusions drawn from these experiments, by authorities.

Sir R. Christison's experiments ("*Edin. Med. and Surg. Journal*," XXXV., p. 320, April, 1831) were conducted in consequence of being consulted in *Case* 20 β. To different portions of the body, one hour after death, of a stout young man who had committed suicide with laudanum, a hot poker and a stream of boiling water were applied. No blister nor redness resulted. Next day the poker burns presented a dried, brownish, translucent appearance, and on the scalded parts the cuticle was easy of removal, and appeared ruffled, the true skin underneath exhibiting no trace of moisture.

In a patient comatose from poison, heat was applied to the skin four hours *before* death, and again half an hour *after* death. The burnt spots were observed thirty-eight hours after death. The parts

burnt during life where the cuticle was entire were blistered, the vesications being filled with serum; whilst on those portions where the cuticle was destroyed, the true skin and parts adjacent appeared glazed, from the exuded and dried serum. Around all these burns there existed a red line not diminished by pressure. The parts burnt after death were mostly charred, but in two places blisters, covered by a dry skin, and containing air and not serum, were noted. The true skin was also dry, and presented no appearance of any exudation having occurred. No redness, moreover, was remarked surrounding these burns.

In experiments on an amputated limb, no vesicles of any kind could be obtained half an hour after its removal, but blisters containing air were easily formed ten minutes after amputation by the application of a hot iron. From these and other experiments Christison concludes:—

(1.) "That the application of heat to the body a few minutes after death is incapable of producing any of the effects due to living reaction.

(2.) "That a line of redness near the burn, not removable by pressure, and the formation of blisters containing serum, are certain indications of the burn having been inflicted during life.

(3.) "That if a vesicle be formed after death, it will be found to contain air and not serum; the true skin underneath the cuticle will be found to be dry, and no redness around the burnt spot apparent."

Casper (Vol. I., p. 300) details a series of experiments on this subject. Wadding soaked in turpentine was fired on the calf of the leg, and the flame of an oil lamp applied to the top of the foot of a woman æt. 60, who had been dead forty-eight hours. In neither case was vesication produced, nor any exudation of serum.

Wadding soaked in turpentine was fired thirteen hours after death on the stomach of a premature child that had lived for twenty-four hours. Fine radiating folds were remarked surrounding the spot burnt. The spot itself became dry and of a light brown color, but there was no trace of vesication.

A flame was applied to the dropsical scrotum of the body of the last-mentioned child. The part burnt contracted, but no trace of vesication resulted.

Casper refers (Vol. I., p. 302) to a most interesting case, where certain bystanders had lighted a straw fire under the body of a drowned man, with the hope of resuscitating him. The body had been recovered from the water almost immediately after submersion. In this

case Casper noted, three days after death, ten or twelve burst bullæ of various sizes up to a walnut. The base of the blisters presented no redness, nor was any redness of the true skin apparent under the blisters when the cuticle was removed.

Numerous other experiments were made, and the following are Casper's conclusions:—

(1.) That by means of flame, vesications may in certain cases, and at almost any time after death, be produced on a dead body. These vesications result from the fluid under the cuticle becoming vaporized by the intense heat applied, the cuticle in this way being elevated above the true skin. They are always of small size, and usually in a few seconds (or at most a few minutes) after their formation burst with a slight crack, the cuticle immediately collapsing. These blisters were never found to contain serum, but watery vapor only; and there were no signs of a red line or of redness on the base from which they spring.

(2.) No blisters of any kind are produced when combustible substances, such as wadding soaked in turpentine, are laid on the body and fired.

(3.) The presence, therefore, of vesications persistent after death, accompanied by a reddened base, are certain indications of the burn being produced during life; and he adds, "It is quite impossible to confound a burn inflicted during life with one inflicted after death."

M. Liman (Casper's "*Vierteljahrss.*," 1863, XXIV., 367) has experimented on five dead bodies, the temperatures of which varied from 78° to 98° F., and at periods varying from one to two hours after death. He notes that a blister may be raised by a spirit flame, but that the vesication results, in his opinion, merely from the fluid under the cuticle becoming vaporized, none of the blisters in his experiments containing serum. The raised skin soon became flat when the source of heat was withdrawn, nor were there any changes indicative of reaction.

Dr. Taylor ("*Med. Juris.*," I., p. 690) states that he has never observed any vesication produced in his experiments with heated iron or with boiling water on the bodies of infants after death. He describes, however (p. 691), an interesting and most important case, where a drowned man, pulseless and to all appearance dead, was immersed in a warm (? hot) bath. When the body was taken out the cuticle peeled off, and several vesications filled with bloody serum were noted. The man was not anasarcous. Dr. Taylor concludes:—

(1.) That the production of a serous blister on a dead body depends on the amount of latent organic life remaining in it.

(2.) That the effects of *hot water* on the living and on the recently dead body may, as in this case so far as vesication is concerned, be similar.

Dr. Chambert ("*Ann. d'Hygiène*," April, 1859, I., 342) has conducted a series of experiments on living persons, and on bodies at various periods up to twenty-four hours after death, to determine the medico-legal importance of blisters as signs of life burns, and the three chief conclusions at which he has arrived are as follows:—

(1.) That blisters (even containing serum) may be caused by heat both on living and dead bodies.

(2.) That in the living, the temperature necessary to produce them is less than in the dead.

(3.) That the serum in a blister produced by a burn on a living body is thick, and sets by the action of heat or nitric acid into a nearly solid mass; whilst the serum of a blister produced on a dead body is thin and watery, and when warmed or treated with nitric acid, merely turns milky or opalescent.

M. Leuret ("*Ann. d'Hygiène*," 1835, II., 387) experimented on a dropsical subject twenty-four hours after death. On applying a heated brazier, he noted that the cuticle was first hardened, after which a blister formed, containing an abundance of reddish-colored serum. He was unable to obtain serous blisters after death in non-anasarcous bodies. He argues: that the conclusions to be drawn from serous vesications as proof of a burn being inflicted during life in the case of anasarcous patients, needs great caution.

M. Champouillon ("*Ann. d'Hyg.*," 1846, I., 421) confirms the experiments of M. Leuret. He further states that blisters may be produced at any period after death, even when putrefaction has commenced, on the bodies of patients afflicted with dropsy. These blisters do not appear in less time than from two to six hours. The serum they contain is rarely tinged with blood.

Dr. Wright, of Birmingham ("*Path. Researches on Vital and Post-mortem Burning*," 1850) has given us some interesting experiments bearing on this point:—

On the body of a woman, æt. 30, who died from acute congestion of the lungs and was slightly dropsical, a spirit lamp was applied to the back of the leg 3½ hours after death, the body being at the time

warm and the joints flexible. In the course of an hour blisters were formed filled with pale straw-colored serum, one blister containing two, and a second three drams.

Experiments of a like kind were conducted on the same body ten and fifteen hours after death, the body being then cold and rigid. Blisters again were produced, but they contained no serum.

Dr. Wright states that he has produced a serous blister on a dead body more than a dozen times, on two occasions within half an hour, and once within fifteen minutes of death, and also on amputated limbs, from half a minute to four minutes after removal.

His experiments led him to conclude:—

That serous blisters may result from post-mortem burns, and that their formation depends on the amount of latent organic life in the body, rather than upon the presence of serum in the cellular tissue (anasarca).

And not to quote further authorities, it may be noted that *Orfila* ("*Méd. Légale*," 1828, I., p. 457) and *Devergie* ("*Méd. Légale*," 1836, p. 273) both express their positive opinion that, from the nature and appearance of the blisters, it is not possible to mistake a burn inflicted during life for one inflicted after death.

I have made a series of observations (conjointly with the late Dr. Woodman) on some twenty-eight bodies from one hour to six days after death, and also on several amputated limbs, to discover how far it was possible to produce blisters by fire or by the application of heated bodies, and if so, in what particulars they differ from those produced during life. Without detailing these experiments, I content myself with stating our conclusions:—

(1.) That in some cases blisters may be produced after death by the application either of a flame (this being the easiest method of all), or of boiling oil, or of molten lead to the skin; but that in no case were we able to produce a post-mortem blister by the application of boiling water.

(2.) That in no case were we successful in producing a blister on an amputated limb at a later period than thirty minutes after its removal, probably owing to the rapidity with which cooling takes place. In the case of dead bodies, however (excluding those that died of dropsy), vesications were formed in two cases as late as eighteen hours, and in several cases as late as twelve hours after death.

(3.) That the majority of these post-mortem blisters were found to contain no fluid whatsoever, the raised cuticle rapidly collapsing after the source of heat was removed. In some few exceptional cases there

was observed under the cuticle a small quantity of a thin watery fluid, containing a mere trace of albumen only.

(4.) That in the bodies of persons who had died with well-marked dropsy, serous blisters could always be produced, and at almost any period after death; but the serum found under such circumstances was invariably thin and watery, rarely tinged with blood, and contained but a mere trace of albumen.

(5.) That in no instance were we able in a dropsical subject to produce a blister by the simple application of boiling water, unless a stream of the boiling water was poured for some minutes on one spot. Even under these conditions we were not always successful.

(6.) That in no case of a post-mortem blister, whether on dropsical bodies, or on the bodies of persons who had died suddenly, or had met their death instantaneously by accident, have we ever noticed the slightest indication of a line of redness around the blister, nor of a reddened *cutis vera* after the removal of the cuticle.

(7.) Our experiments entirely confirm the observations of *Chambert*, that the serum exuded in a blister formed during life is thick and rich in albumen.

And here three further points must be recorded:—

(1.) That in certain badly nourished people, or in those suffering from phthisis, starvation, etc. (as Guy points out), blisters, not unlike those produced by fire, may be found on the trunk or on the extremities. Such blisters and sores (so-called "burnt holes") were very common in the great Irish famine.

(2.) That if a burn be inflicted on a person in a state of insensibility, where the vital powers are much depressed, no line of redness or vesication may result; nevertheless on the patient reviving and recovering sensibility, the vital signs of blisters and of the red line dividing the dead from the living tissues, may then become apparent. (*Case* 15.)

(3.) That bullæ frequently form on a dead body as the result of putrefaction. The absence both of the red line of demarcation and of a reddened state of the *cutis vera*, together with the presence of green discoloration of the skin generally, and on the *cutis vera* in particular when the cuticle is removed, will at once dispel any doubt as to the cause of these blisters.

And these two conclusions I think the facts warrant:—

(1.) Given a burn on a dead body where there are serous blisters, the serum being thick and rich in albumen, and the blisters surrounded

by a deeply injected red line, the true skin after the removal of the cuticle also presenting a reddened appearance, the evidence is strong that the burn was produced during the life of the person, whilst it is conclusive that it was caused during the life of the part. Thus in *Case* 18 a red line and a serous blister resulted from a burn inflicted on a child during a life which only lasted a quarter of an hour. In *Case* 37, again, a new-born child was boiled in water. The medical jurist stated that the blisters indicated that the child was living when first put into the water, although the soddened state of the lungs prevented the application of the hydrostatic test.

(2.) Given a blister containing air, the true skin after the removal of the cuticle appearing dry and unglazed, of a dull white color, or dotted with grey specks at the opening of the sudoriferous ducts;—or given a blister containing a little thin non-albuminous serum, there being in neither case any red line surrounding the blister, nor any injected condition of the *cutis vera* or subcutaneous tissues, the evidence is strong that the burn was inflicted after death.

10. *Was the Death by Burning Accidental, Suicidal, Homicidal or the result of Spontaneous Combustion?*

Omitting for the moment any reference to the so-called spontaneous combustibility of the body under certain unusual conditions, we may remark that death from burning is more likely to be accidental than either suicidal or homicidal, and less likely to be suicidal than homicidal. *Case* 42 is, however, an illustration of suicidal burning.

As regards *accidental* death from burning, it by no means follows that the person will be found dead at a spot *near* the fire which had caused the accident. On the contrary, it is more likely that a person who accidentally catches fire, would be found after death at some distance from the fire. We know that when such an accident as the clothes catching fire occurs, it more frequently than not happens that the person runs frantically out of the room and house, crying for assistance. Nor, again, does the fact that a dead body is found near a fire, necessarily suggest murder, or positively exclude accident, for the person might have been intoxicated when he caught fire, or have been unable to move from the spot by reason of disease.

It will be all important in a case of this kind to examine the body for marks of violence—such as fatal cranial injuries, marks of a cord, etc. It must be remembered, however, that marks of violence (except-

ing fractures) may be entirely effaced by burning—indeed, that the burning may have been effected for the express purpose of destroying the evidence such injuries would otherwise afford of homicide. Thus the conclusions to be drawn, even from the absence of such marks in cases of burning must be carefully considered. (See *Cases* 21, 22 and 32.) On the other hand, the conclusions to be drawn from the presence of wounds on a body burnt to death, require careful consideration, seeing that wounds of very considerable extent may result from the application of heat only. (*Cases* 23 and 24.) In all wounds found on bodies in cases of burning, this question must be considered—Were they caused by violence previously to the burning, or were they the result of the burning?

Another question here presents itself—

Given severe wounds on a dead body, evidently the result of violence, and in addition marks of burning sufficient to account for death, whether is the death to be attributed to the wounds or to the fire?

This question occurred in *Case* 22, and its importance consisted in the fact that if the wounds had been the cause of death, the prisoner, on his own confession, was guilty of murder; but if the fire, he might have been innocent of the death.

In these days, when cremation amongst a certain class is lauded as a grand hygienic system for disposing of the dead (utterly forgetful, in the desire to be strong-minded and unsentimental, that such a rapid destruction of evidence may often defeat the ends of justice, and in no small degree suggest, and act as an incentive to, crime), burning may be adopted as a means for disposing of the dead body of a person that had come to his end naturally. (*Cases* 30 and 31.) But it may be far otherwise. Criminals with criminal intent, and for the purpose of ridding themselves of awkward evidence, may cremate a body, and plead the simple adoption of a sanitary improvement as the motive. Or even if the burning be not carried so far as this, certain portions of a body may be cremated, in order to destroy marks of violence that might otherwise convict. In all such cases the exact position of the burnt body in its relation to the fireplace and to surrounding furniture must be noted. The extent to which other articles near the body, as chairs, carpets, etc., are scorched or burnt should be carefully examined, always remembering, however, that the evidence afforded by these details has only a certain limited value, seeing that murderers frequently arrange matters to suggest accident or suicide, and so to break the scent of the authorities.

In these cases general evidence will be of chief importance. The hearing of a quarrel between the husband and wife, previous to the

smell of burning being recognized, was the chief ground of the verdict in *Case* 20 β.

Of course the probabilities in such cases must be weighed. It is, for instance, more likely that a blacksmith working at his forge, or a cook at her kitchen fire, would be accidentally burnt to death, than that such an accident would occur to a merchant in his office.

We shall discuss the so-called spontaneous combustion of the human body in another chapter.—(See Index.)

11. *Burns produced by Acids and other Corrosive Bodies.*

The crime of maliciously throwing corrosive liquids over persons was at one time very prevalent. By the 24 and 25 Vic., c. 100, s. 29, this offence is especially mentioned, and punishment provided. It is said that on one occasion a prisoner escaped the charge of felony, because he was indicted for wounding, the judge deciding that sulphuric acid would not produce a wound! (R. *v.* Murrow, Liverpool, 1835.) This statute, however, does not define a wound, but mentions the nature of the fluid thrown, as "any corrosive fluid, or any destructive substance," which would include dynamite, nitro-glycerine, etc.

The law regards the act of throwing acids, etc., over a person, whether he be injured or not, as a felony.

There is no very definite recorded case where by throwing acids over a person, death has been caused *directly* from the burn. In *Case* 41 death was said to have resulted from the use of a nitric acid liniment. In another case (*Case* 39) disease of the brain and death resulted from nitric acid having been poured into a man's ear; and in a third case (*Case* 40) death is stated to have been the result of phlebitis, after bleeding performed for a severe ophthalmia, resulting from a sulphuric acid burn. There are many cases, however, where serious results, such as the loss of an eye, etc., have accrued from the throwing of corrosives.

To distinguish burns of this nature from heat-burns, it may be noted that the resulting eschars are commonly soft, and not dry, and that the line of redness dividing living and dead tissues is usually very slight. The skin covering the burn is generally of a leathery consistency, and when the part injured is cut into, the tissue affords no indication of congestion, such as we usually find in heat-burns, whilst the true skin in many cases will be found destroyed. The burns produced by corrosives, further, are of singularly uniform color, and very different in this respect from ordinary heat-burns; where various de-

grees of injury from redness upward will probably be noted. Blisters do not result from the burns produced by corrosive agents, whilst they invariably result from the action of heat, unless there has been entire destructive charring of the skin. Again, in heat-burns we shall probably discover on some parts, and probably on the parts unburnt, a blackening of the skin produced by a deposit of soot set free during combustion. Further, in a heat-burn, the hairs in the neighborhood of the burn will probably be found scorched. Both of these indications will be absent in the case of burns produced by corrosive agents. And, lastly, if acids be thrown over the person, it is next to certain that some will be found on the dress and clothes of the victim, which must therefore be carefully examined for stains, the nature of which will have to be determined.

To differentiate burns produced by the various acids or caustic alkalies (for these latter are corrosive fluids, and as injurious in their action as acids), the color of the stains must be most accurately noted. Thus, sulphuric acid leaves a brown, nitric acid a deep yellow, and hydrochloric acid a faint brownish-yellow stain. The chemical reactions of the stains will, however, probably set at rest the actual acid or corrosive agent employed.

ILLUSTRATIVE CASES.

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1. **London Med. Record, Jan. 15, 1878.**—(*Dr. Farchini-Bonfanti.*)—A healthy child, æt. 5, was put to bed in a wicker cradle, in its night-dress, and covered over with the usual clothing. Two hours afterward the friends found that the room in which it was sleeping was on fire. The child was found to be dead, and a wardrobe and some articles of linen contained in it, in flames. The bedroom was filled with a thick smoke. The child had apparently died of suffocation, but there were many slight burns found on its body, both front and back. The wardrobe was three quarters of a yard from where the child was lying. In this case there was no doubt that the woman who had put the child to bed had unconsciously set the linen in the wardrobe on fire. There was no reason to suspect a criminal act. (Pages 92, 101, 103, 108.)

2. **Med. Times and Gaz., April 26, 1854, p. 406.**—Death from tetanus, after recovery from the primary effects of burns. (Pages 102, 103, 104.)

3. **Swansea Lent Assizes, 1869.**—(Referred to by *Dr. Taylor*, Vol. I., p. 687.)—Burns from a fire-damp explosion. Recovery took place from the primary effects, but death occurred after three months' continuous illness from inflammation and ulceration of the bowels. (Pages 103, 104.)

4. **Casper, Vol. I., p. 315.**—A girl, æt. 6. Scald from boiling coffee, extending from the left ear over half the back of the right axilla, down the right side of the thorax, and the right upper extremity. Death in eight days. *Post-mortem:* Brownish patches and granulating sores noted; pleurisy of the right side with recent bands of adhesion; serous effusion into pericardium; right side of heart full of cherry-red, half-coagulated blood, and the left side empty; rest of body anæmic. (Casper decided death was due to thoracic inflammation.) (Pages 106, 107, 108.)

5. **Guy's Hospital Reports, 1860, Vol. VI., p. 146.**—(*Dr. Wilks.*)—A boy, æt. 2. Scalds on face, neck, and chest. Death on eighth day. No special post-mortem appearances discovered. (Page 107.)

6. Casper, Vol. I., p. 313.—(*Case* cxliii.)—Male, æt. 68. Scalded to death in a hot (?) bath. The scald affected two-thirds of the body, and death occurred in two hours. *Post-mortem:* Epithelium lay in tatters over the brownish-red *cutis vera;* nails of fingers and toes wanting; great congestion of brain; right side of heart distended; blood black and grumous. (Pages 94, 97, 98, 106, 108.)

6a. British Med. Journ., April 29, 1871, p. 456.—A lunatic scalded to death in a hot bath. The attendant was charged with manslaughter. (Page 94.)

6b. Lancet, Jan. 8, 1876.—Death of a child from a scald, from being placed in a bath at too great a temperature. (*See* "British Med. Journ.," Jan. 15, 1876, p. 80.) (Page 94.)

7. Guy's Hospital Reports, 1860, Vol. VI., p. 146.—(*Dr. Wilks.*) —Girl, æt. 9. Clothes caught fire, causing severe burns on the upper part of the chest and on both arms. Death on the ninth day. Twenty-four hours before death she became restless, and tetanic stiffness of the limbs and body was remarked, but no convulsions. At the post-mortem all the organs (even the brain and spinal cord) were found healthy. (Pages 102, 107.)

8. Casper, Vol. I., p. 314.—(*Case* cxliv.)—Male, æt. 83. Burnt to death sitting in a chair before the fire, from his clothes accidentally catching alight. Body (except legs) completely carbonized. The back so destroyed that, on attempting to straighten it, it broke. On the right side the fissures were so deep that the thorax and abdomen could be seen into, and the roasted condition of the liver recognized. (Page 100.)

9. Casper, Vol. I., p. 316.—Boy, æt. 1½. Clothes caught fire. Death in two days. *Post-mortem:* Apoplectic congestion of brain; inflammation of trachea; red hepatization of inferior lobe of right lung. (Pages 107, 108.)

10. Casper, Vol. I., p. 316.—Female, æt. 81. Death after several days, from a severe burn, involving the nates, including vulva and perinæum, from her clothes catching fire whilst warming herself before a stove. *Post-mortem:* Red hepatization of upper lobe of left lung; other parts anæmic. (Page 108.)

11. Casper, Vol. I., p. 317.—Female, adult. Burnt to death from her clothes taking fire whilst drunk. In this case Casper states that, from the appearances, some of the burns were inflicted during life, and others

after the woman was dead. The character and contents of the vesications are the main points on which he relies for this opinion. Death, he considered, was due to asphyxia, the right side of the heart being gorged with dark red fluid blood. Lungs, trachea, and other parts normal. (Pages 107, 108.)

12. Med. Gazette, Vol. XXV., p. 743.—(*Mr. Long.*)—Account of the post-mortem appearances recorded in cases of burning. (Page 104.)

13. Lancet, Jan. 6, 1872, p. 11.—(*Mr. Hulke*).—Male, adult. One-fifth part of the body surface burnt by falling into fire. Highest temp. reached, 101.2. Alive on the twelfth day. (Page 99.)

14. Amer. Journal Med. Sciences, Jan., 1861, p. 137.—Female. Superficial burn, involving lower part of body. Death on 13th day. Stomach inflamed at its greater extremity. More or less inflammation of the intestines as far as the cæcum. (Page 107.)

15. Ogston's Med. Juris., p. 462.—A woman, in a state of insensibility from cold, had tins of hot water applied to her feet and sides. The flannels in which they were wrapped got disarranged, so that the tins came into contact with the skin. Two hours afterward when she was examined, no redness or vesication was visible where the heat had been applied ; the next morning, however, when the woman had well-nigh recovered from the insensibility of the previous day, the parts were found extensively blistered, with broad patches of redness. (Pages 110, 112, 117.)

16. Lancet, 1863, I., p. 60.—(*Dr. Buzzard.*)—Case of six children burnt to death in December, 1862. (Page 108.)

17. Taylor's Med. Juris., Vol. I., p. 689.—(*Mr. Jackson, of Stamford.*)—Death from burning. *Post-mortem :* Lungs congested ; cavities of heart empty. There were reasons to believe that the burning was done after death to conceal strangulation, but there were also indications that some of the burns had been inflicted during life. (Pages 106, 107, 108.)

18. Taylor's Med. Juris., Vol. I., p. 692.—A child that survived its birth about a quarter of an hour, had a burn purposely inflicted on the right leg during its life. *Post-mortem* (10 days after death) : Cuticle entirely destroyed, the under surface being scarlet and much injected. There was a vesicle filled with serum on the scrotum, with *a red line of inflammation* around its edge. (Page 118.)

19. Casper, Vol. I., p. 314.—Two children (boy æt. 7, and girl æt. 3) burnt to death in one fire. Death was due in both cases to asphyxia. On the girl, however, burns were abundant, but on the boy no injuries from fire were apparent. *Post-mortem:* In both, the trachea contained dull-colored, frothy mucus, discolored with black particles of soot, the lungs and venous trunks of thorax and abdomen being distended with dark fluid blood. The stomachs of both contained food, the large intestines were full of fæces, and the bladders empty. In both the brain-substance was congested, and the surface of a rosy red tint. In the boy the right heart contained half-a-tablespoonful, and in the girl half-a-teaspoonful of dark fluid blood. In the boy the liver and right kidney were congested, and the small intestines of a rosy red color; but these appearances were not recorded in the post-mortem on the girl. (Pages 105, 107, 108.)

20. Med. Gazette, Vol. VIII., p. 170.—(*Dr. Duncan.*)

(*a*). Case of Gilchrist (Glasgow).—A man found guilty of murdering his wife, and afterward burning her body. The body was so burnt, that medical evidence as to the cause of death was rendered impossible. The defence was that her clothes caught fire whilst she was intoxicated. In this case, however, lodgers in the same house had heard noises as if of a struggle, and the smell of fire succeeded the noises. There was no trace of burning either of the house or furniture. (Pages 106, 108.)

(*β*). Case heard at Leith.—In many respects this case was similar to the above. A forcible entrance was effected to the room, when a woman (who was then dead) was found burning, a red light issuing from the clothes, whilst in an inner room the accused was found asleep, or pretending to be so. The deceased was found on the hearth, the clothes only partially burnt, and the furniture uninjured. At the post-mortem parts of the body were found carbonized, the abdomen being reduced to a cinder. On the face and extremities some parts were scorched to a hard transparent crust, surrounded by a distinct redness, whilst other parts were merely red and inflamed. There were also many blisters filled with serum on the body. The medical evidence, for these reasons, was to the effect that the burns were inflicted during life. Verdict, "Not proven," on the ground that it might have been accidental.

[The important question here was, might the redness and blisters have occurred if the burning had been effected immediately after death, by other violence, such as strangulation?] (Pages 98, 108, 112, 120.)

21. Taylor's Manual, p. 348.—Murder of the Countess of Goerlitz. The deceased was first strangled; the prisoner (Stauff) then placed the body in a chair, piled combustible articles of furniture around it, and set fire to them. (Page 119.)

22. **Casper, Vol. I., p. 308.**—(*Case* cxlii.)—Murder of Widow Halke, aged 70, by Fritze. The woman had been subjected to violence, and the body afterward burnt. The question was, Did the woman die from the violence (of which the prisoner was undoubtedly guilty), or from the effects of the fire (of which the prisoner might have been innocent)? Vesications were found on the body, some of which contained serum, others being empty. The post-mortem showed clearly that asphyxia was the cause of death. The question then arose, was the asphyxia the result of strangulation (which the prisoner denied) or the effect of fire? A stoppage to respiration might have resulted from an injury to the nose that the victim had sustained, and to the circumstance that after the prisoner had stunned the woman, he turned her face to the floor. Although the fire was so severe that the whole of the clothes were consumed, and the body carbonized, yet Casper thought the fire was insufficient, supposing the woman to have been alive to cause the asphyxia. (The case is most remarkable.) (Page 119.)

23. **Taylor's Med. Juris., Vol. I., p. 696.**—A boy, æt. 2 years, was severely burnt, and died three quarters of an hour after the accident. In this case there were gaping wounds in each knee, and a fissure about 2¾ inches long in the right thigh, also transverse lacerations above and below the knee on the left side. The edges of the fissures were not uneven, but lacked the smoothness of ordinary incised wounds. The fissures themselves were about 3 lines wide and 2 deep, exposing the fatty tissue beneath which was white, and free from any effusion of blood.

Mr. Curling considered these wounds due to the action of heat. It was noted that small blood-vessels ran across the fissures, which, being more tenacious than the fatty tissue, had not yielded to the heat. (Pages 100, 119.)

24. **Casper, Vol. I., p. 307.**—(*Case* cxl.)—A young chimney-sweep was roasted to death by a fire being lighted during the time he was sweeping a chimney. He was not carbonized, but his entire skin was of a coppery-red color, with isolated yellow patches. The skin was parchmenty, in many places fissured, the molten fat having flown out, and varnished the parts around. (Pages 100, 106, 119.)

25. **Casper, Vol. I., p. 308.**—Five persons completely carbonized in a fire. Not a trace of soft parts were visible. Certain parts in each skeleton were wanting. (Page 120.)

26. **Casper, Vol. I., p. 315.**—Girl, æt. 2½. Burnt on the private parts, by falling on a hot smoothing-iron. Death in eleven days. *Post-mortem:* Vagina soft and gangrenous; blood fluid; trachea bright red,

and covered with frothy matter; lungs pale and anæmic. (Pages 92, 107, 108.)

27. **Ann. d'Hyg., 1847, Vol. II., p. 424.**—(*M. Boys de Lowry.*)—A mother accused of pouring melted pewter (tin 3 parts, and lead 7 parts; melting-point 340° F. = 171.1° C.) into the right ear of her idiot son, whilst he was asleep. Pain and violent inflammation resulted. Recovery. (Page 92.)

28. [We have been unable to trace the following anecdote to a more ancient source than the "Dictionnaire d'Anecdotes," etc., published by La Combe, Paris, in 1766, although it refers to the time of the first Edward.] The book says (p. 361), "A pretty citizeness of London had had six husbands, one after the other: the first to please her parents, the rest to please herself. One of her countrymen was brave enough to allow her to make him her seventh husband. For a few months all went merrily. Her fondness, perhaps, made her indiscreet. She told her husband all the faults and follies of his predecessors. She disliked some because they were sots, others because they were unfaithful to her. In short, she had no good words for any of them. The husband, suspecting something, and wishing to test the character of his wife, began to stay out late, and to appear drunk when he returned. She first reproached him, then began to threaten; but he continued to stop out late, and to feign drunkenness, even more often than before. One night when she believed him dead drunk, and fast asleep, she took a lead button from the sleeve of her dress, melted it in a pipe, and approached the pretended sleeper, to pour the melted metal into his ear. The husband, no longer doubting her guilt, seized her, cried for help, and gave her up to justice. She was first imprisoned, and then tried, the dead bodies of her six husbands being exhumed, and all bearing witness against her, by the discovery of lead in their ears and brains. On this evidence she was condemned to death. Hence the origin of coroner's inquests in England." (Page 92.)

29. **R. v. Newton.**—(*Shrewsbury Assizes,* 1849.)

30. **R. v. Cook.**—(Case of Mr. Paas.)—Attempt to dispose of a body by burning. (Page 119.)

31. **R. v. Good.**—Ditto. (Page 119.)

32. **R. v. Taylor.**—(*York Lent Assizes,* 1862.)—Death probably from strangulation, burning of the body being afterward attempted in such manner as to appear to have been the cause of death and accidental. The medical evidence showed that the burns exhibited no signs of vesication. (Page 119.)

33. **R. v. Gaitskell.**—(*Carlisle Spring Assizes*, 1872.)—The prisoner was convicted of manslaughter under the following circumstances:—He poured a quantity of petroleum over the clothes of the deceased. By accident the vapor caught fire, and the resulting burns caused the man's death on the following day. (Page 95.)

34. **R. v. King.**—(*Liverpool Summer Assizes*, 1847.)—A woman convicted of throwing boiling water over her husband for the purpose of maiming him. (Pages 92, 94.)

35. **R. v. Blewitt.**—(*Worcester Summer Assizes*, 1847.)—A case similar to No. 34. (Page 94.)

36. **R. v. Hill.**—(*Stafford Summer Assizes*, 1859.)—Similar to Cases 34 and 35. (Page 94.)

37. **R. v. Goodfellow.**—(*Winchester Assizes*, 1876.)—The body found of a child which had been boiled in water. The question was, had it been put in the water dead or alive? One medical witness stated that the water had so destroyed the lungs that it was impossible to test them. A second, relying on the presence of blisters containing serum, believed the child was living when placed in the water. The prisoner was acquitted. (Pages 94, 118.)

38. **Foderé, Vol. III., p. 18.**—The case of a man who murdered several individuals with an axe in 1809, and then set fire to the house in which they lived. The medical officer did not examine the bodies, but certified that their death was due to the fire. Meanwhile, an individual was discovered about one hundred paces from the house, who had evidently been murdered, and suspicion being aroused, the bodies of the others were disinterred. It was then found that the flames had only burnt the flesh superficially, and that the marks of the axe were still distinctly visible.

[Dr. Dunlop (MS. Lectures) mentions a similar case occurring at Glasgow in 1809. A man murdered his wife and then set fire to her clothes. There were, however, marks of external violence sufficient to convict him.

In the State of Maryland, a few years since, a ruffian murdered a whole family, and then fired the log-house in which they lived. On the body of the father, however, a fracture of the skull was found; and in consequence of a bed from the upper room falling on the mother, her body was so far uninjured as to exhibit three incised wounds, one of them penetrating the stomach. The murderer was detected by finding on him articles of dress belonging to the family.] (Page 105.)

39. Med. Gazette, XVII., p. 89.—A man poured strong nitric acid into his wife's ear whilst she was asleep. She died after six weeks. Great exhaustion. Complete deafness. Loss of the use of the right arm, and before death, convulsions in the right half of the body. Bleeding and suppuration from the ear.

P. M.: A portion of the external ear wanting. Petrous portion of temporal bone carious, and the brain near it softened. Death, no doubt, resulted from disease of the brain, the effects of the acid. (Page 120.)

40. R. v. Macmillan.—(*Edinburgh*, 1827.)—("Ed. Med. and Surg. Journ.," April, 1829, p. 230.)—A man had sulphuric acid thrown over him. Severe ophthalmia resulted, for which the surgeons bled him. The man died of phlebitis. (Page 120.)

41. Case of Miss Cashim.—(*Taylor*, Vol. I., p. 698.)—Death from great local mischief, following the use of an escharotic liniment containing nitric acid. (Page 120.)

42. Taylor's Med. Juris., Vol. I., p. 695.—"A case of attempted suicide by fire occurred in Newgate, in December, 1871. One of the prisoners was found in his cell with his clothes, and part of the bedclothes, much burnt, and with severe burns on the body. The gaslight in the cell was so placed that no accident could account for the fire; but all the facts concurred to show that the man had done the act deliberately. He gave no alarm, but a moaning was heard in his cell, and this caused the warder to enter and make the discovery in time to save him." (Page 118.)

43. British Med. Journ., March 23, 1872.—(*Mr. Lawson.*)—Female, æt. 23, went to bed intoxicated and set fire to her bed. She was so drunk that she could not get out of the room, and was compelled to breathe the smoke and hot air. Great pulmonary congestion resulted. Death on the fifth day from exhaustion.

44. British Med. Journ., May 1, 1875.—(*Mr. Parker.*)—Female, æt. 3. Scald of glottis by the child placing her mouth to the spout of a tea-kettle from which steam was issuing. The immediate effects seem to have been only slight, croupy breathing not occurring until the third day. On the sixth day no visible injury was apparent, but there was a deposit of a diphtheritic membrane in the pharynx, larynx, and bronchi. Tracheotomy. Death on the eighth day. (Page 94.)

Query.—Was the formation of the membrane the result of the scald?

45. British Med. Journ., June 19, 1875, p. 809.—(*Mr. Sympson.*)

—Boy, æt. $2\frac{1}{2}$. Scald of glottis by drinking boiling water out of a tea-kettle. Tracheotomy. Recovery. (Page 94.)

46. British Med. Journ., Nov. 20, 1880, p. 806.—(*Mr. Cochrane.*) —Female adult. Injured surface, 7 in. × 4 in. on the head, and 8 in. × $4\frac{1}{2}$ in. on the shoulder and forearm. Recovery.

47. Medical Times and Gazette, Oct. 23, 1880, p. 485.—(*Mr. Hutchinson.*)—Male, 56. Scald of the head with boiling water. Gangrene of arm, necessitating amputation near the surgical neck of the humerus. Recovery after five months. (Pages 94, 103.)

CHAPTER IV.

LIGHTNING.

General Considerations.—Experiments with the Induced Spark.—Symptoms produced by Lightning.—The Causes of Death.—Treatment.—Post-Mortem Appearances.

(Illustrative Cases, page 143.)

Lightning accidents occur more commonly to males than to females, from the circumstance that they more frequently attack those in an exposed position. Exceptional cases are, however, recorded where persons have been struck in places by no means exposed, and as we should suppose singularly safe. Thus in *Case* 40, a boy was struck by lightning whilst in bed; in *Case* 44, a child's clothes caught fire, and the chair in which she was sitting was shattered, and in *Cases* 43, 43*a*, and 45, the houses in the first instance were fired and the inmates more or less injured. Cases of railway signal men and of telegraph clerks being struck by lightning at work in their boxes have occurred within the experience of the author.

The forensic aspects of the subject are not unimportant. Thus the effects of lightning may simulate those of violence, and lead to a suspicion of foul play. This suspicion may be increased by a dead and wounded body being found in a lonely country lane, partly stripped of its clothes. (*Case* 45.) In all such cases the circumstances of the death need to be fully considered.

Further, the injurious effects of lightning may prove important in questions of insurance. (See page 10.) (*Case* 1.)

Some few points of general interest bearing on this subject require consideration :—

(1.) *Lightning* is the spark or flash observed during a sudden discharge of atmospheric electricity. The identity of the lightning flash with electricity of great quantity was first noted by Franklin. The accompanying phenomena of *light*, of *heat* (for the lightning current will melt thin metal wires (*Case* 46) and at times even siliceous substances, producing the tubes called fulgurites), of *magnetism* (as evi-

denced by the power of lightning to magnetize articles of steel, so that watches stop, magnetic needles have their poles inverted, and telegraph signals are interfered with), are some of the effects whereby this similarity becomes evident. Further, electrical conductors are lightning conductors, and electrical non-conductors are lightning non-conductors. And once again, the influence of lightning and electricity on chemism (as, for example, the power possessed by each of intensifying atmospheric oxygen) affords additional proof of this identity.

(2.) Experiment shows that the lightning flash does not last longer than the $\frac{1}{1000}$th part of a second. For this reason an object in motion when seen by a flash of lightning, appears motionless. And again, objects (such as the spokes of a rotating wheel), which, from their rapidity of movement would not be recognizable by ordinary illumination, become visible when seen by the electric flash. These two facts may have considerable medico-legal interest.

The possibility of seeing things and people by lightning, so as afterward to recognize them, we have already discussed. (Vol. I., p. 212.)

(3.) During a thunderstorm *fire-balls* or meteorites have at times fallen. They are said frequently to rebound once or twice from the earth, and then to explode violently.

(4.) *Thunder* is the sound due to the disturbance produced by a lightning discharge. The long rolling effect probably depends on echoes from clouds, or to a number of discharges taking place at different distances.

(5.) *The Varieties of Lightning.*

(α.) *Sheet Lightning.*—This appears as a diffused reddish white, or violet flash, seemingly spread over a considerable extent of sky. It is probably due to a discharge inside the cloud. The *color of the flash* varies with the state of the atmosphere and with the elevation.

(β.) *Forked Lightning.*—This appears as a zigzag line of light passing between cloud and cloud, or between cloud and earth. It resembles the discharge from the prime conductor of a frictional machine, taking the path of least resistance. The light is white and brilliant.

(γ.) What is called *Heat Lightning* is, unlike sheet or forked lightning, unaccompanied by thunder (" Silent," or " summer " lightning). It seems to be the reflection from aqueous vapor and clouds of a discharge occurring beyond the horizon, or it may depend on the discharge taking place at such an elevation that the thunder cannot be heard.

A special cause of accidents arises from what is called " the *return shock*." And this form of lightning stroke derives importance from the circumstance that its effects are usually very severe, immediate death frequently resulting, without any injury being apparent on the

clothes, or marks present on the body. Thus it may be difficult in such cases to find proof of the cause of death. In most cases where lightning has proved fatal, the severity of the injuries are such that they might lead to a suspicion of criminal violence (although usually there is sufficient evidence from the general surroundings, from the appearance of the clothing and of the dead body itself, to guide us in this matter); nevertheless, as we have said, it must not be forgotten that lightning shocks of great severity may leave no marks whatsoever behind them.

(6.) "It is not known," says Fownes, "to what cause the disturbance of the electrical equilibrium of the atmosphere is due. Experiment has shown that the higher regions of the air are usually in a *positive* state, the intensity of which reaches a maximum at a particular period of the day. In cloudy and stormy weather, the distribution of the atmospheric electricity becomes much deranged, clouds near the surface of the earth often appearing in a *negative* state. The circumstances of a *thunderstorm* exactly resemble those of the charge and discharge of a coated plate or jar, the cloud and the earth representing the two coatings, and the intervening air the bad conducting body. The polarities of the opposed surface and of the insulating medium between them become raised by mutual induction, until violent disruptive discharge takes place, through the air itself, or through any other bodies which may happen to be in the interval." The fact then is, given a lightning flash, and nothing to interfere with its free passage (in other words, that the discharge meets with no imperfect conductor), it does no harm. But if its free passage be interfered with (in other words, if imperfect conductors come in the path of the discharge), serious results must occur. And such an imperfect conductor is the human body.

As regards living muscle, Ranke considers its conducting power is 3,000,000 times weaker than that of mercury, and 15,000,000 times weaker than that of copper. (Brown-Séquard, "Proc. Roy. Soc.," No. 44.)

Dr. Richardson's experiments lead him to believe, that the blood is a better conductor of electricity than either water, muscle, or nerve matter, whether grey or white. The course of lightning through the body, therefore, would be preferentially by the blood.

The principal cause, then, of the injury effected by lightning, depends on the imperfect conductivity of the body, and its interposition between cloud and earth. The very varied results, therefore, of the flash may be easily accounted for by variations in the conducting power of the clothes worn by the person, or unequal conductivity re-

sulting from one part of the clothes being dry and another part wet, a circumstance fully sufficient to explain the irregularities in the direction of rents. Wet clothes are better conductors than dry clothes:—thus wet clothes may, under certain circumstances, save a man. Irregularities, again, in the direction and intensity of wounds and burns may depend on the different conducting power of different articles of clothing worn at the time. Thus, when flannel is worn next the skin, the burns are invariably more superficial than when cotton is in contact with it. Or, again, irregularities may depend on the various metallic substances worn, or on differences in the conductivity of the various tissues themselves.

As regards the general question of the best and safest position in a thunderstorm, it is undoubted that to take refuge under a high solitary tree is a dangerous position. A low tree, a clump of trees, or a hedge, are less objectionable, whilst a wood is least of all open to danger. Further, it is certain that a corn or hay rick is an unsafe shelter, because if it is dry, it is a worse conductor than the body. The open country is equally objectionable, because in such cases the person is the only object for attack. The recumbent is safer than the upright position, and to lie down in a furrow is better than to lie on a ridge.

As a rule, trees, buildings, etc., conduct the current fairly well, but if any circumstance happens whereby they are rendered bad or inferior conductors, they will probably be destroyed. In the case of buildings, dangerous effects are now in a great measure obviated by the use of *lightning-rods*, the nature and arrangement of which, however, demand a number of precautions. If *lightning-conductors* are meant to protect a building, they must be sufficiently thick and massive to conduct the electricity, and further, they must be absolutely continuous (hence chain conductors are not to be recommended), and well connected with the earth. It is a good plan to connect the lightning-rod with the large water-pipes of a building, and care should be taken that all out-lying metal on the roof should be connected with the conductors by strong wires.

Experiments with the Induced Spark.

Considerable light has been thrown on the phenomena of death by lightning, by the experiments of Dr. B. Ward Richardson ("*Med. Times and Gazette,*" May 15th, 1869, and May 11th, 1870) with the large induction coil, formerly at the Polytechnic Institution. The

battery used in his experiments consisted of forty-eight Bunsen cells, the primary wire of the induction coil being 3,770 yards, and the secondary wire 150 miles in length. The central core was of soft iron wire five feet long, four inches in diameter, and 125 pounds in weight. With this instrument three kinds of sparks were obtained:—

(1.) When the secondary wire was simply charged from the primary wire, a thick spark of 29 inches long was obtained. It had two flames—an inner line of thin, blue flame, surrounded by a thick burning flame. The latter could be blown aside by a bellows. As regards the physiological effects of this form of discharge, Dr. Richardson has shown that the injury caused by it is not great. Thus it merely singed the feathers of pigeons or the fur of rabbits, and produced anæsthesia only after several discharges had been transmitted. A frog took 25, a pigeon 15, and a rabbit 30 discharges without being killed.

(2.) When the break was used, a blue, intense, forked, and almost continuous spark of 10 to 15 inches was obtained. This was also tolerably harmless if merely passed on the outside of the body, but the contraction of muscles induced by it was more or less permanent. If passed *through* the body, the effects were more powerful, although even then death seldom resulted.

(3.) When a Leyden battery of 40 square feet was charged, a most dangerous and fatal kind of spark resembling artificial lightning was obtained. With this variety, if the current was passed *through* a body and not stopped by feathers, etc., one or two discharges were usually fatal. The animals frequently retained after death the last attitude of life, and no marks in the majority of cases were found upon them. But even this kind of discharge, it was noted, had two effects—the one on voluntary motion and common sensation, which was not fatal; and the other on respiration and circulation, which was fatal.

The following were Dr. Richardson's conclusions:—

1. That lightning kills by an intense shock, like that of the Leyden jar.

2. That the fatality of an electrical or lightning shock is in proportion to its *intensity*. And here it is to be noted that there are two kinds of shock;—one producing temporary contraction of muscles and insensibility from which recovery is possible, and a second killing directly, by producing a condition of nervous and general muscular insensibility.

3. That the kind of covering with which the body is furnished makes a great difference. Fur and feathers are protective.

4. That in those not killed, the reception of the shock is not remembered (accurately at least) owing to its instantaneousness. It is, therefore, *probably the most painless of deaths.* [Dr. Richardson advocates its use judicially, and also to kill animals for the table.]

5. That those discharges, which, from their intensity, kill most readily, leave fewest and least marks of external injury.

6. That after what appears to be general death, the heart may continue to beat for several minutes.

Now that the use of powerful galvanic batteries and dynamo-machines are becoming common, it is by no means unlikely that some deaths (accidental or otherwise) may happen from a sudden discharge passing through the human body. (*Case* 49.) A careful examination of the exact position of, and the markings on, the body, should in such cases be at once made. Note should also be taken of its proximity and relation to the battery, the nature of the battery, the arrangement of wires, commutators, conductors, etc.

The use of electricity medically should most certainly be in the hands of qualified medical men only, as much as the use of the knife. Bad results arising from improper treatment are not unrecorded. ("*Med. Times and Gazette,*" 1877, II., p. 577.)

Symptoms.

In cases where death is not immediate, we find as a rule sudden insensibility, the person falling down as though in a fit, the respirations being slow and labored, the pulse feeble and irregular, and the pupils dilated (*Cases* 8, 11 β, 24, 30, 32, and 43 α), and insensible to light. In *Case* 10 the pupils are reported as contracted. I have seen them contracted on the side of the shock, and dilated on the opposite side. Even in very slight cases, the person frequently falls down as if stunned, and perhaps foams slightly at the mouth. The first thing that may strike an observer is, that the clothes worn by the patient are torn, singed, burnt, or smell of fire. (*Cases* 9, 11 β, 13 *a* and γ, 32, 38.) Sometimes they are carried to a distance, and the person left stark naked. (*Case* 45.) And here must be noted two important facts:—(*a*) That the clothes may be torn and burnt without any corresponding injuries on the body (*Case* 35); whilst (β) severe body injuries may occur without the clothes suffering. (*Cases* 11 *a* and 41.)

These anomalies probably depend on whether the garments have been wetted or not by the storm, or how much of them are wet and how much dry, the rain rendering the clothes good conductors of the electrical current. (*Case* 41.)

Burns and blisters are common results of the lightning stroke. (*Cases* 2, 3 α and β, 4, 5, 18, 39, 41 α and β, 45.) The burns may at times be due to the clothes having caught fire, but that this is by no means necessarily the case, is proved by the circumstance that burns may exist when the clothes are not injured. Further, Dr. Richardson's experiments with the induced spark sufficiently indicate that burns of great severity may or may not result, according to the nature of the flash. At times the burnt spot on the body is at some distance from the actual point where the discharge entered or found an exit. (*Case* 3 β.) Sometimes the burns may be of so intense a nature as to cause charring or sloughing of the parts, this condition being mostly dependent on metallic substances worn at the time becoming heated by the current. (*Cases* 3 α and 19.) The heating power that lightning possesses is well illustrated in *Case* 46. The hair is frequently found to be singed (*Cases* 10, 11 β, 13 γ, 19, 20, 32.) In some cases there is a marked absence of all burning. (*Cases* 9, 22.)

Wounds as though caused by the stab of a blunt dagger are not uncommon. These may be accompanied by a bruised condition of the parts. (*Cases* 2, 9, 13 γ, 16, 21, 35.)

Livid streaks and ecchymosed spots are very frequent. (*Cases* 3, 4, 10, 14, 20, 21, 23, 30, 31, 32, 33, 34, 35, 42.) It is said that ecchymosed spots are most common on the back (Meyer), and that they usually indicate the entrance or exit, or both, and the livid streaks the passage, of the electric current. Frequently the marks assume a peculiar arborescent appearance (*Case* 47). This may depend on the course of the veins, or on the disposition of metallic bodies about the person. Such peculiar marks are very indicative of death by lightning. And this further point is worth noting, that if marks on the skin be caused by the contact of metallic substances (and the thinner such metallic bodies are, the more likely they are to produce marks), it may be determined by analysis what was the actual metal causing the stain. In this way it would be possible to show that the deceased carried about with him a body of a certain composition.

Fractures from lightning are rare. In *Cases* 9, 37 and 48, fractures of the skull are recorded, accompanied, in some cases, by loosening of the sutures. (*Case* 9.) In one case, a fracture of the os calcis together with fractures of the tibia and fibula, is stated to have occurred. (*Case* 45.)

And here two remarks are suggested—

(1.) The appearances presented by a patient suffering from lightning stroke may closely resemble the results of violence. Of course the existence of a thunderstorm and various other points in the case will, as a rule, render the diagnosis easy.

(2.) That cases are recorded where, after death by lightning, no marks of external violence have been visible. (*Case* 36.)

A severe lightning shock is often associated with various nervous and other symptoms, some of which are as follows:—

1. *Blindness or injury to sight.* (*Cases* 7, 29.) In *Case* 29 the injury was total and permanent.

2. *Deafness* (*Case* 19), or *noises in the ears.* (*Case* 25.) Bleeding from the ears is recorded in one case (*Case* 11 β), and in two cases lacerations of the membrana tympani are stated to have occurred. (*Cases* 11 β and 21.)

3. *Dumbness* or *difficulty of articulation.* (*Cases* 7, 19, 22.)

4. *Tetanus* (*Case* 28); *tetanic* and *epileptiform symptoms.* (*Cases* 6, 30 and 34.)

5. *Constipation* (*Case* 15) *and retention of urine.* (*Cases* 9, 15, 19.)

6. *Paralysis* (*Cases* 14, 15, 16 β and 43), (hemiplegia), (*Cases* 11 α, 14 and 19), (paraplegia), (see also *Cases* 1, 18, 25). In *Case* 9 paralysis was more or less complete. Although some neurosis ordinarily occurs, exceptional cases are found where there is none. (*Case* 41.)

7. *Cardiac affections.* (*Case* 43.)

8. *Insanity.* (*Case* 26.) Great excitement (although very occasionally) has been recorded. (*Cases* 14, 22, 27, 39.)

9. In addition to the above, *apoplexy* (*Case* 6), *loss of memory* (*Case* 27), *headache* (*Cases* 15 and 43), *severe dyspnœa* (*Case* 43), and the discharge of blood from the mouth and nostrils (*Case* 22), are also recorded.

It will be seen that the prominent symptoms resulting from the lightning stroke arise from its effects on the nerves of motion and sensation. Still more remarkable is the variety in its results at different times, and in different individuals at the same time. Bearing on these differences in the form of the paralysis induced, the experiments of Nothnagel on the effects of electrical discharges on rabbits are full of interest. (Virchow's *Archiv.*) He discharged a Leyden jar repeatedly through some part of the body of an animal by placing the points of the electrodes *beneath* the skin. This mode of experiment was rendered necessary, because when the electrodes were merely placed *on*

the skin, its resistance was found to be so considerable that it was impossible to control the course of the discharge. One electrode being placed in the groin, and the other beneath the claws of the hind or fore leg, no motor disturbance and no loss of sensibility whatsoever resulted in the groin when the shock was passed, but loss of sensibility occurred in the foot, sharply limited, however, by the articulation of the foot with the leg. If the electrodes were so placed that one was in contact with a hind paw and the other with a fore paw, anæsthesia took place in both feet as far as the foot articulation, but there was no loss of feeling in the intermediate parts. This singular limitation of the anæsthesia was found to involve in like manner the deeper parts, including the nerve trunks. Thus, when the foot was the point of entrance or of exit, it, and it alone, was rendered anæsthetic.

The shock was next sent from the fore paw to the tail. The tail, extending as far as the insertion of the muscles at the root, and the foot, were both rendered anæsthetic. In one case of feeble discharge the tail only suffered. By why this limitation? Arago has stated that when lightning strikes men or animals placed near together, its action on the extremities is always the most severe. This may explain the intensity of action at the extreme points in the feet and tail. But the real difficulty is that, if one electrode be placed on the foot and the other in the groin, or trunk, or thigh, there is no such limitation as regards these latter parts. Possibly this may be explained by the rapid diffusion of the electricity in these regions.

The anæsthesia produced in Nothnagel's experiments was complete but transient (say of one or two hours' duration), and often succeeded by a transient hyperæsthesia. Motor disturbances were not conspicuous. Complete, but transient paralysis of the leg was, however, caused if the electrodes were placed, the one on the front, and the other on the back of the thigh, so as to include between them the sciatic nerve. Paresis of the hind legs was also caused when the electrodes were placed on each sciatic nerve, the motor weakness corresponding to the anæsthesia. During the paralysis a distinct diminution existed in the electrical irritability of the nerve. (See "*Lancet*," June 5, 1880, p. 883.)

Nothnagel's experiments show that the partial paralysis of lightning is to be regarded favorably.

The *causes of death* from lightning are various. Thus, it may kill like any other shock. It may also kill by the severity of the resulting burns and wounds. It may kill, again, by causing a rupture of structures necessary to life, and disorganization of tissues. Hunter supposed death by lightning was due to the destruction of the con-

tractility of the muscles; and Richardson considers its instantaneous effects to be dependent on a combination of shock and the sudden conversion of the animal fluids into a gaseous form.

The *capricious action of the discharge* may be illustrated by a variety of cases. Thus, in *Case* 13, one man was killed, whilst two others by his side at the time escaped without injury. In *Cases* 12 and 33 one man was killed, whilst two others were injured, but soon recovered. A similar result is recorded in *Case* 41. Again, in *Case* 12, we find the intensity of the discharge centred in a *low* tree, although *high* trees, an iron bridge, and a lightning conductor were in the immediate vicinity. Again, in *Case* 2 we have an illustration how the same discharge may produce in one person burns and in another wounds. (*Case* 39.) Again, numerous cases are recorded that show how comparatively slight circumstances may determine results. Thus, in *Case* 15 the passage of the flash followed the line of a telegraph wire, through a clock in communication with it, and through the key to the man who was winding it up at the time. In *Case* 14 the contact of the man's hand with the door bolt determined the course of the discharge. Similarly, metal hairpins and earrings (*Case* 4), or steel corsets (*Cases* 3 α and 4), or iron hoop skirts (*Case* 4), or buckles on abdominal belts (*Case* 20), or watches and watch-chains (*Cases* 11 β, 13 β, 16 β), have all been causes of some of the apparently eccentric results of lightning.

The remarkable and capricious action of the discharge is illustrated in a singular manner by its effects on clothing, of which the cases quoted supply numerous illustrations. *Case* 45 is one of the most remarkable of these on record. Perhaps this stripping off of clothes, which frequently occurs to a greater or less extent, depends on the force resulting from the formation of a large body of steam.

As regards the results of 54 cases collected in the "Illustrative Cases," 21 died and 33 recovered. Recovery may take place even after very severe shocks, where anæsthesia and paralysis have been present. (*Case* 19.) The time of recovery varies within great limits, from a few days to some months (*Case* 15), when recovery may be either complete, or (what is not infrequent) associated with various bad results, such as—

(1.) Epilepsy.
(2.) Paralysis and anæsthesia or hyperæsthesia.
(3.) Catalepsy.
(4.) Blindness or injury to sight. (*Case* 29.)
(5.) Permanent loss of memory. (*Case* 27.)

The time of death, as a rule, follows *immediately* on, or at the most very soon after the shock; if not, recovery may be hoped for. Thus, of thirteen cases of death where time is recorded, seven were instantaneous; one was after a short interval; one was on the second day (*Case* 22); two on the third day (one of these resulting from tetanus) (*Cases* 7 and 28); one on the ninth day (*Case* 16 β); and one on the thirty-third day (*Case* 14).

Treatment.

The application of cold to the head, a blister to the nape of the neck, mustard poultices to the legs, and the administration of stimulating and nourishing injections are indicated.

Dr. Richardson strongly advises in such cases venesection as *the* remedy. ("*Med. Times and Gazette*," Dec. 17, 1870, p. 694.)

The patient must be treated afterward according to the symptoms that present themselves.

Post-mortem Appearances.

Death, as we have said, may be instantaneous, in which case the body may be found after death in the exact attitude in which it was struck. (*Case* 17.) (Vol. I., p. 53.) In other words, rigor mortis may occur *immediately* after death. Sometimes, however, it supervenes after several hours. (*Cases* 9 and 16 *a*.)

John Hunter appears to have been deceived by the transient and early post-mortem rigidity occurring in some cases, and to have supposed that *cadaveric rigidity* was absent in death from lightning. We now know (and on this point the author has had personal experience) that rigidity does occur, and that it is often well marked and prolonged. It is also perfectly certain that the blood coagulates after death from lightning, although coagulation is often slowly developed.

The face after death usually exhibits a very bloated and discolored appearance (*Cases* 1 and 20), the head being the part which is usually first struck. (*Cases* 20, 23.) Putrefaction is frequently very rapid. (*Case* 1.)

Contusions, lacerated wounds, burns and blisters, ecchymosed spots (*Case* 23) and lines often assuming a tree-like shape (arborescent) (*Case* 47) are common appearances. Fracture of the bones of the skull (*Case* 9) and of other bones (*Case* 45) are recorded. Loosening of the sutures of the skull is also said to have occurred. (*Cases* 9 and 48.)

A charred spot has been noticed in a bone at the spot through which the electric spark passed. (*Case* 9.)

Dr. Richardson remarks that in animals killed by electricity the blood is commonly dark (venous), but that on exposure to air it rapidly changes to the ordinary arterial red color.

The *brain and its membranes* usually suffer the most severely. Thus, at the seat of the injury, blood may be effused under the skull. (*Case* 9.) The membranes may be much congested (*Case* 20), and even lacerated. (*Case* 9.) The brain itself has been found congested with bloody fluid in the ventricles. (*Case* 9.) A blood clot has been recorded in various parts, such as in the left cerebral hemisphere. (*Case* 16 β.) Sometimes the brain substance appears to have suffered complete disorganization (*Cases* 9 and 21), whilst at other times it has been found normal. (*Case* 48.)

The *lungs* (together with the air-passages) have been found congested (*Cases* 9 and 20), and even injured. (*Case* 21.) The bronchi and air-tubes were recorded in one case to be full of mucus. (*Case* 20.)

The *heart* in one case was said not to have had much blood in it (*Case* 20); and in another, the right side was said to be full, and the left empty. (*Case* 48.)

Of the *abdominal viscera*, a generally congested condition has been noticed (*Cases* 9 and 20); whilst in other cases they have been recorded as normal. (*Case* 48.)

Metallic substances about the person may be fused (*Case* 4), whilst any steel articles in the pocket, such as a knife, etc., may acquire magnetic polarity. (*Case* 35.)

ILLUSTRATIVE CASES.

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1. Law Times, Mar. 14, 1846, p. 490.—("Taylor's Med. Juris.," p. 135; "Comptes Rendus," Sept., 1845, and "Medical Gazette," 36, p. 1133.)—A case tried in France in October, 1845, in which medical evidence was given of considerable importance respecting the character of wounds caused by lightning. In August of that year some buildings at Malauny, near Rouen, were destroyed, either by a thunderstorm, according to the one side, or by a whirlwind, according to the other. As the persons whose property was destroyed were insured against lightning, they sought to recover damages accordingly. The evidence as regards lightning consisted (1) in the alleged carbonized appearance of the leaves of some of the trees and shrubs growing in the vicinity; and (2) in the characters of the wounds on the bodies of several persons who were injured at the time. M. Lesauvage deposed to the occurrence of dark stains scattered over the bodies, and that the survivors suffered from torpor, pains in the limbs, and partial paralysis of motion. He also observed that those killed speedily putrefied. In one case the muscles were torn across in a ragged manner, and some small arteries were divided. M. Funel deposed that the face and neck in some of the dead bodies were bloated and discolored, as if the death had occurred from asphyxia. M. Pouillet described the storm, but although he did not deny that there may have been thunder and lightning, he thought the trees and buildings were simply overthrown by the wind. [It is unusual for young and green trees to present any marks of combustion about the leaves or trunk.] The Royal Court of Rouen, without deciding the exact mode of the occurrence, condemned the insurance company to pay the amount claimed. (Pages 131, 138, 141.)

2. Beck, p. 522.—("London and Edinburgh Philosophical Magazine," Vol. I., p. 191.)—A lady and gentleman were struck by lightning. The injuries on the lady were actual *wounds*, whilst those on the man were *burns*. (Pages 137, 140.)

3. Lancet, Aug. 6, 1870, p. 185.—(*Mr. Simon.*)—(*a.*) Female. The lightning singed the eyebrows, and inflicted a charred burn from the

chin, passing over the forepart of the body, to the ankles. Above the left groin were some sloughs, supposed to have been produced by the heated metal of the stay busk. The pubic hair was burnt off, and the legs blistered. Recovery. (Pages 137, 140.)

(β.) Male. The lightning passed through the trousers at a point immediately above the left outer ankle, and through the elastic of the boot, which, on the outside, was the only part affected, the woven tissue being frayed away from the elastic. The burn passed downward and forward, inflicting no wound until it met the expanse of the dorsum of the foot, where it inflicted a quadrilateral burn. (Page 137.)

4. **Amer. Journ. of Med. Sciences.**—(*Dr. Holton.*)—Female, æt. 61. Remarkable burns produced by lightning. The woman was at work in an out-building, and the lightning, after shattering a tree, penetrated the wall of the building, and struck her on the back of her head, where she wore two wire hair-pins. The burn from this point passed down by the right ear (in which was a gold earring), across the throat, and down to the left of the sternum. The burn was 3 inches wide, and blistered. The second line of burn commenced on the left side, and passed down to the symphysis pubis. The third line of burn was from the patella of the right knee to the bottom of the heel, from which it passed off, bursting open the heel-seam of a strongly sewed gaiter boot. Portions of the wires of the hoop-skirt were melted. Certain detached burns Dr. Holton accounts for by the presence of metal ribs in her corset.

Symptoms.—Insensibility, from which she recovered in twenty minutes. (Pages 137, 139, 140, 142.)

(See also "Edinburgh Medical and Surgical Journal," Vol. XII., p. 493; also "Lancet," Vol. VI., p. 910, and Vol. VII. (N. S.), p. 255, for a case of lightning stroke, accompanied by very *extensive burns, blistered skin,* and *livid streaks.*)

5. **New York Medical and Surgical Register, p. 55.**—Case of lightning stroke, by *Professor Stevens,* with extensive *vesication.* (Page 137.)

6. **Edin. Med. Chir. Trans., Vol. I., p. 360.**—*Dr. Macauley* reports three cases of lightning stroke, one followed by *apoplexy,* and two by *epilepsy.* (Page 138.)

7. **Lond. Med. and Phys. Journal, Vol. XLVII., p. 369.**—*Mr. Godfrey* tells of a sailor struck *dumb* and *blind* by lightning. (Pages 138, 141.)

8. **American Journal of Medical Sciences, Vol. XIII., p. 54.**—

The *pupils were dilated* in a series of cases of lightning stroke recorded by *Drs. Young* and *Stevens.* (Page 136.)

9. Lancet, July 20, 1872, p. 77.—(*Drs. Clark* and *Brigham.*)—Male, æt. 74. Struck by lightning, whilst standing under a tree, on an eminence, in a thunderstorm. The shock threw him on his face, and he became unconscious. The lower extremities were completely, and the upper partially paralyzed. The hat, jacket, and boots were destroyed. The hair was burnt off on all parts, the mouth lacerated, and there were several small bleeding wounds, but these presented no signs of bruises. The following day the bladder was found to be paralyzed. Death occurred on the third day.

Post-mortem.—A very fine fracture of the squamous portion of the temporal bone, 1¼ inch long, with a second at right angles, was found. The temporal bone was forced outward. An irregularly triangular piece of bone, black and charred, was found between the fractures. Other bones of the head were also charred. The sutures of the temporal bone were loosened. Thick, but uncoagulated blood was found beneath the dura mater. The membranes were much torn and congested. The right side of the brain was so soft as to resemble pus. Much bloody fluid was found in the ventricles. Rigor mortis was slow in appearing. The skin was in parts charred, and very tough. (Pages 136, 137, 138, 141, 142.)

10. Medical Times and Gazette, July 13, 1872.—(*Mr. Richards.*)—Female struck with lightning whilst sitting near a cactus hedge at Orissa. The hedge itself was in parts carbonized, and in others riddled. She was rendered almost insensible. The pupils were contracted, and the conjunctivæ congested. The hair on the left side was burnt, and there was great discoloration of the left temple. Recovered after five days. (Pages 136, 137.)

11. British Med. Journ., Aug. 3, 1872, p. 114.—(*Mr. J. R. Lane.*)—Two men struck by lightning whilst taking shelter during a thunderstorm under an oak tree. (Pages 136, 137, 138, 140.)

(*a.*) One man seemed to suffer from shock. There was loss of power in the lower extremities. The clothing was uninjured, and there were no ecchymoses. Recovered the next day.

(β.) The other man was unconscious for ten minutes. This was succeeded by collapse, with widely dilated pupils. He said he felt as though he had had a severe blow. Bleeding from right ear. Bruises. Hair singed. Current diverted by watch-chain and watch, which were completely destroyed. Clothes much injured. Partial paralysis. Recovered, but the tympanic membrane was found lacerated.

12. Ann. d'Hygiène, 1871, p. 1, 478.—M. Tourdes relates the following:—"In 1869 three soldiers sat under a tree during a storm. They were struck down by lightning, and two were killed on the spot. There were loftier trees in the neighborhood, and a lightning conductor was not far off, and an iron railway bridge and a river were near. The electric fluid struck the lower tree, and passed through the bodies of the men, in place of being carried off by the surrounding conductors." (Page 140.)

13. Taylor's Med. Juris., Vol. II., p. 134.

(*a.*) In June, 1871, a coachman was killed, whilst driving, during a storm, and the footman, sitting by his side, escaped uninjured. The lightning struck the coachman on the head, destroyed his hat and rent his clothes. It passed through his body, tore a large hole in the cushion on which he was sitting, and, except the shattering of the glass, did no injury to the carriage nor to those inside.

(*β.*) At the same time and during the same storm three men were mowing in a field. They put down their scythes and sought shelter; but as they were leaving the field, they were all three struck to the ground by the lightning. One only was killed. It was found that he had been struck on the right side, where he wore a steel chain to his watch, which was broken to pieces.

(*γ.*) In another case, occurring at the same time, a man, aged seventy-four, was struck whilst standing under a fir-tree. He was taken up insensible, and soon died. There was a jagged wound over the right eye, and a great part of the surface of the body was burnt, including the hair, whiskers, eyebrows, and eyelashes. The boots were burnt off the feet, and the hat and trousers were torn to pieces. (Pages 136, 137, 140.)

14. Lancet, June 28, 1873.—(*Dr. Wilson.*)—Male, adult, struck by lightning whilst bolting a door in his barrack-room. Remained insensible for ten minutes. [A rifle placed in the rack in the room was struck at the same time, the lightning penetrating the scabbard of the bayonet, and punching out a hole about the size of a pea. The surface of the bayonet corresponding with this hole was partly molten. The stock was shattered to pieces.] A diffused swelling of the right forearm (the member nearest the bolt), with diminished sensibility, but not impaired motion, was noticed. Both legs, from the knees downward, had lost their sensibility. The patient was very excited. Sensation returned about the fifth day. Recovered entirely on the tenth day, and suffered no inconvenience afterward. (Pages 137, 138, 140, 141.)

15. Berliner "Klinische Wochenschrift," No. 17, April 26, 1875; and London Medical Record, Vol. III., No. 125, p. 320, May 26, 1875.—Eulenburg records a very curious case of *hemiplegia* with

subsequent recovery, from the *effects of lightning.* The patient was a pointsman, aged forty-two. On the night of August 4–5th, 1873, he was winding up a clock in the signal department of the Berlin-Stettin Railway. He had just inserted the key with his left hand when a flash of lightning flew along the telegraph wire into the clock, thence to the key, and thence to the left half of his body. He at once became insensible, and this state lasted for a full hour. On recovering consciousness, he dragged himself into a waiting-room. On examination there was found to be *total loss of motor power in the left arm and leg, and considerable loss of common sensation,* and of the localization of impressions. Headache, insomnia, vertigo, slight muscular tremors, constipation, and retention of urine were felt for a few days, and then passed off. After ten months the leg improved but the arm remained in *statu quo.* It hung down quite limp, and all movements seemed abolished, except in the fingers and thumb. The *nutrition of both limbs was also much impaired.* Under treatment by the constant current, etc., he gradually improved, and at the end of seven months was nearly as well as ever. (Pages 138, 140.)

16. **Med. Times and Gazette, June 20, 1868, p. 671.**—(*Dr. G. R. Barnes.*)—Two men struck by lightning whilst standing under a tree with their horse during a thunderstorm. Both men and the horse were knocked down, and one man was killed.

(*a.*) The man who was killed was struck on the side of the head. A circular wound was found over the fourth rib, into which the finger readily passed. Rigor mortis twelve hours after death.

(*β.*) The other man (æt. 41) was unconscious, pulse small, respiration slow, but not stertorous, and paralyzed on the right side. His watch-chain was fused into small fragments, and the watch itself pulverized. The skin in the course of the chain was reddened, and blistered where the watch rested. Several wounds were found on the leg. The clothes were much injured. Death on the ninth day.

P. M. *A blood clot found in the left cerebral hemisphere.* (Pages 137, 138, 140, 141, 142.)

17. **Med. Times and Gazette, Feb. 18, 1860, p. 167.**—Death in this case was so sudden that the body retained after death the attitude in which it was struck by lightning. (Page 141.)

18. **Fleming.**—("Glasg. Med. Journ.," Oct., 1859, p. 257.)—Eight cases of lightning stroke. Several were burnt severely, and their dresses singed. Some were benumbed and more or less paralyzed, but all recovered. The burns took some months to heal. (Pages 137, 138.)

19. **Taylor's Med. Juris., p. 131.**—*Mr. Hill* mentions that a man

was burnt by lightning on the nape of the neck, where a metal watch-chain rested. From the spot where the current left the chain, the skin was blistered in a straight line down to the feet, scorching the pubic hairs. He had paraplegia (loss of motion and sensation) with retention of urine, deafness, difficulty of articulation, dysphagia, and a metallic taste in his mouth.

The anæsthesia passed away in half an hour, the retention in twenty-four hours, and the paralysis in four days. (Pages 137, 138, 140.)

20. **Oesterreich. Med. Wochenschrift, June 6, 1846.**—(Quoted almost *in extenso* by *Dr. Taylor, loc. cit.*, p. 132.) In a case reported by *Dr. Schaffer*, a healthy middle-aged laborer was working with others in a field, supposing that the thunderstorm was over. He was trying to strike a light with a flint and steel, when the lightning struck him. For a moment after the shock he stood still, and then fell heavily to the ground dead.

Post-mortem: The electric fluid had pierced and torn the hat at the upper part of his forehead; it seems then to have been divided into two currents, which passed down the sides of the body, along the lower limbs, and out at the feet. On the upper part of the forehead a soft swelling of a dark blue color, about the size of the palm of the hand was found, the hair covering it being uninjured. From this spot two dark red streaks proceeded in different directions. The left streak, when it reached the left groin, formed a large irregularly scorched (*brandige*) patch, passing onward to the dorsum of the left foot, terminating in several small dark blue spots. The other streak, pursuing its way on the right side, formed a similar burn or scorched patch in the right groin, and ended, like the other, on the foot. The hair on the forehead was not burnt, but the pubic hairs were completely burnt. This was ascribed to the buckles of an abdominal belt, which was completely destroyed. *Post-mortem:* About four ounces of extravasated blood found in the swelling on the head. The membranes of the brain were much congested, and the choroid plexuses particularly so; bronchi and air-tubes full of bloody mucus; the lungs, stomach, and intestines greatly congested; the right lobe of the liver and spleen also much congested. There was not much blood in the heart and large vessels. Beneath the burnt patches much blood was found extravasated in the substance of the abdominal muscles. (Pages 137, 140, 141, 142.)

21. **Heller's Journal, Feb. 1845, p. 245.**—In this case the hat and shoes of an old man killed by lightning were destroyed, but the garments were uninjured. The left ear was severely lacerated. Black longitudinal lines were found on the skin of the abdomen, an ecchymosed spot on the skin of the left ankle, and a deep wound on the foot. The whole of the

left hemisphere of the brain was disorganized and liquefied, except the *corpus striatum.* There were injuries to the left lung. (Pages 137, 138, 142.)

22. **Lancet, June 5, 1880, p. 885.**—(*Dr. Nothnagel.*)—A man struck with lightning. Remained unconscious for five hours. Paralysis of the right hand, there being in the middle of the back of the hand a brown spot where, probably, the electricity had entered. Recovered under the influence of magnetism, but had a relapse six years afterward, which was cured by the application of a magnet to the hand (?). (Pages 137, 138, 141.)

23. **Travels to St. Petersburg, Vol. II., p. 112.**—A case of lightning stroke is mentioned by Dr. Granville, in which the only mark visible was a red spot on the forehead. The legs were blue, and one shoe was torn, but not burnt. (Pages 137, 141.)

24. **Medical Gazette, Vol. XIV., p. 654.**—A non-fatal case of lightning stroke. The person was seen soon after and was found laboring under the following symptoms:—Insensibility; deep, slow, interrupted breathing; relaxation of all the muscles; slow, soft pulse and dilated pupils, the latter sensible to light. (Page 136.)

25. **Medical Times, July 15, 1848.**—Noises in the ears, paralysis, and other neuroses succeeding severe lightning strokes. (Page 138.)

26. **Conolly's Report of Hanwell, 1839.**—Insanity is said to have resulted from the shock of lightning. (Page 138.)

27. **Lancet, Aug. 3, 1839, p. 582.**—Three days' delirium and entire loss of memory after a lightning stroke. (Pages 138, 140.)

28. **Medical Times and Gazette, May 26, 1855.**—A boy, aged four, had tetanus on the third day after a lightning stroke, and died in four hours after it set in. (Pages 138, 141.)

29. **Medical Times and Gazette, July 24, 1858.**—Frontal headache and total loss of sight occurred to an old man, who felt as if a vivid flash had struck him in the face whilst standing under a tree during a storm. He did not fall. (Pages 138, 140.)

30. **British and Foreign Medical Review, Oct., 1842.**—Three persons struck by lightning. One of them, aged 26, an hour and a half after the stroke, lay completely insensible, as if apoplectic. His pulse was

below sixty, full and hard, pupils dilated and insensible, respiration noisy. Thumbs and jaws firmly fixed. Twitchings of arms and hands, succeeded by severe spasms, with the body drawn to the left side. He was afterward bled and blistered, cold being applied to the head, and sinapisms to the legs. Stimulant enemata and opium were given. He recovered consciousness after 24 hours, and soon got quite well. The only external mark was a red streak as broad as a finger, extending from the left temple over the neck and chest. This disappeared completely after a few days. (Pages 136, 137, 138.)

31. **Dr. Horstmann (Casper's "Vierteljahrsschrift," April, 1863, p. 308.)**—Red streaks or marks resembling trees or veins resulting from lightning. (Page 137.)

32. **Australian Medical Journal, September, 1870, p. 295.**—"In this case a youth was killed by lightning, and there were contusions on his left side, which was extremely rigid. His back hair was burnt off. Both pupils were dilated. His nose bled from the left nostril. The surgeon who examined him stated that he noticed on the skin of the chest the perfect impression of a young tree, inverted! It appeared of a dark color, as if tattooed. It was just like the trees which grew near! When struck he had two or three layers of woollen cloth buttoned over his chest. His cap was torn to pieces. The trousers on the left side were rent from the hip to the stocking; the latter and the boot were torn open. He died from injury to the brain." (Pages 136, 137.)

33. **Lancet, July 30, 1864, p. 118.**—(*Taylor, loc. cit.*, p. 129.)—*Dr. Mackintosh*, of Littleport, was called in May, 1864, to see three persons who were struck by lightning twenty minutes before. They had taken shelter under a hay stack, which had been set on fire by the same flash. No. 1, male, æt. 10. In this case the shock was slight. He had difficulty in moving his legs at first, with pain in lower part of abdomen, and red streaks on chest and abdomen. Recovered in about four days. No. 2, male, æt. 11. In this case the shock was severe. The boy had epileptiform symptoms, and similar red streaks, whilst his hair was singed at the back of the head and neck. He became conscious in five hours and rapidly recovered. No. 3. A man, aged 46, was killed on the spot where he was sitting. Rigidity came on fourteen hours after. He had a large lacerated wound of the scalp, dividing blood-vessels and nerves. His right ear was livid and swollen. There was a dark blue mangled patch of skin above the right collar-bone. His hair was singed. In his left trousers pocket were lucifer matches and a tin tobacco-box, not affected, but a knife in his right pocket was strongly magnetized. In neither of these three were the buttons melted, or the clothes, which were very wet, torn. (Pages 137, 140.)

34. **Medical Times, May 3, 1845, p. 182.**—No marks apparent in several severe cases of lightning stroke. (Pages 137, 138.)

35. **Taylor, Vol. II., p. 129.**—(*Dr. West.*)—A case in which a lad, æt. 18, was killed by lightning. His pocket-knife had acquired strong magnetic polarity. His boots (full of hobnails) were torn to pieces, but his feet appeared uninjured. In fact, although the dress was much injured, there were no marks of injury on the body immediately covered by the garments destroyed. (Pages 137, 142.)

36. **Taylor, Vol. II., p. 129.**—A case of a man instantaneously killed by lightning. There was a hole in his cap, his hair was singed, his trousers torn, his shoes burst open. The woodwork of the building down which the electric fluid passed was merely split, and there were no marks of burning. (Page 138.)

37. **Pouillet.**—("Traité de Physique," Elect. Atmosph.)—A case of lightning stroke where the skull was fractured and bones depressed. (Page 137.)

38. **Taylor's Med. Juris., Vol. II., p. 131.**—(*Dr. Geoghegan.*)—A girl struck by lightning. The thighs and buttocks were burnt, but her clothes were not burnt. (Page 136.)

39. **Taylor's Med. Juris., Vol. II., p. 131.**—(*Mr. Fisher*, of Dudley.)—A case of a man milking a cow in a shed during a thunderstorm. The cow was killed at once by the flash. The man was severely burnt from the right hip to the shoulder. The sleeve of his shirt was also burnt, but his arm was not injured. He had delirium and inflammatory fever, which lasted seventeen days. (Pages 137, 138, 140.)

40. **British Med. Journ., Sept. 11, 1880, p. 437.**—A boy, in bed, struck by lightning, and rendered insensible. The lightning entered by the door. (Page 131.)

41. **British Med. Journ., June 22, 1876.**—(*Dr. Jeffries.*)—Three persons struck by lightning whilst hoeing in an open turnip field. (Pages 136, 137, 138, 140.)

(a.) Female. Became unconscious. Eyebrow singed. Scorched across the chest, one arm seeming as if scalded. Severe headache. No paralysis. Recovery in fourteen days.

(β.) Boy. Much frightened. There was no broken skin, but a scorch on one leg, tree-shaped. Recovery rapid.

(γ.) The man had a very slight shock indeed.

In neither case were the clothes nor metal articles about them injured.
(Dr. Jeffries states that near the spot six sheep were killed by the lightning, and that he was unable to find any marks upon them either externally or internally.)

42. **Philosophical Transactions, Vol. XLIX., p. 61.**—The death of Professor Richman at St. Petersburg, in 1753, was caused whilst experimenting on atmospheric electricity. On the left side of the forehead, where he was struck by the electric current, there was a round ecchymosed spot. There were eight other patches of ecchymosis, of variable size, from the neck to the hip, and chiefly on the left side. Some were like marks of gunpowder discharged in contact with the skin. The left shoe was torn open at the buckle, without being singed or burnt ; but the skin around was slightly ecchymosed. A quantity of blood was found extravasated in the windpipe, the lungs, and the layers of the omentum. The omentum appeared as if greatly bruised. (Dr. Taylor refers to Murbach's "Encyklopädie," article "Blitz," and Henke's "Zeitschrift der S. A.," 1844, Vol. I., p. 193, for further accounts of this case.) (Page 137.)
Beck refers to other similar cases in "Philosophical Transactions." (See footnote to Beck, p. 522.)

43. **Edinburgh Med. Journ., March, 1873.**—(*Dr. Ogston.*)—A dwelling-house containing ten inmates, all at the time being in the kitchen, was struck with lightning. The whole were stunned and thrown down. On recovering consciousness after a few minutes they found themselves (excepting two children) little the worse for the accident, but the house a wreck. The effects produced on the house and its surroundings closely resembled those of an explosion. It is singular that the inmates generally suffered so little harm. (Pages 131, 138.)

43a. **Deutsche Klinik, June 20, 1874.**—*Bugge* mentions the case of a delicate girl struck by lightning whilst in a room. At first, he says, she only had headache, dilated pupils, dyspnœa, and palpitation. After twelve days she had systolic and diastolic bruits over the heart. In six days more right hemiplegia set in, and on the thirty-third day she died. There was no post-mortem examination. (Pages 131, 136.)

44. **British Med. Journal, Feb. 26, 1870, p. 212.**—Death of a girl from lightning whilst sitting at a table. A bright flash was seen, part of the house was struck, and the child's clothes were set on fire. The chair on which she sat was shattered to atoms. Death in a few hours. (Page 131.)

45. **Med. Times and Gazette, Nov. 1, 1879, p. 515.**—(*Dr. Wilks, of Ashford.*)—Three men struck by lightning in a lodge. Instantaneously

the building seemed enveloped in flames. In the case of a fourth man, who was standing under a tree which had been struck, the effects were most remarkable. His boots lay at the foot of the tree, whilst his clothes were scattered in a line for several yards along the field, the man himself being stretched on his back, six feet away, stark naked, and calling for aid. He says he felt himself violently struck across the chest and shoulders, hurled through the air, and dashed upon the ground, but is sure he never lost consciousness. He was more or less burnt all over. The os calcis was fractured, and there was a compound comminuted fracture of the right tibia and fibula. He showed no signs of shock, and recovered perfectly. (Pages 131, 136, 137, 140, 141.)

46. **British Med. Journal, July 26, 1879.**—(*Dr. Brock.*)—A girl with two needles in her dress, standing at a window during a thunderstorm, found the needles very hot, and her dress smouldering at the spots where they were inserted. She herself felt no shock. (Pages 131, 137.)

47. **Lancet, Aug. 10, 1878.**—(*Dr. Waugh.*)—Male, adult, struck by lightning whilst standing under a tree. The injury resulting seems to have been singularly tree-like in appearance. There was nothing about the man to account for the arborescent appearance of the burnt surface. (Pages 137, 141.)

48. **Lancet, Aug. 18, 1877.**—(*Dr. Hefferman, of Melbourne.*)—In a post-mortem after death by lightning there was found on removing the scalp a clot of blood over the right forehead and a thin layer of semifluid blood over an area of 2½ inches on the front of the right hemisphere of the brain beneath the membranes, corresponding to the bruise on the forehead. The brain substance was normal. There was a diamond-shaped fracture of the right orbital plate of the frontal bone. The right side of the heart was full of dark liquid blood, and the left side contracted. All the internal organs were healthy. (Pages 137, 141, 142.)

49. **British Med. Journ., Jan. 31, 1880.**—Male, æt. 30, sudden insensibility, and death in forty minutes by taking hold of the battery wires used for an electric light. (Page 136.)

CHAPTER V.

COMBUSTIBLES AND EXPLOSIVES.

A.—Solid Combustibles, Etc.:—Coal.—Lime.—Lampblack.—Sulphur.—Gunpowder.—Gun-cotton.—Phosphorus.—Dynamite.—Metallic, and other Combustible and Explosive Compounds.—The Spontaneous Combustion (1) of Dry Organic Substances, (2) of Organic Substances Moistened with Water, and (3) of Organic Substances Moistened with Oil.—Human Spontaneous Combustion.

B.—Liquid Combustibles:—Petroleum.—Boiler Explosions.—Nitro-Glycerine.—Bisulphide of Carbon.—Alcohols.—Ethers.—Turpentine.—Benzol.

C.—Gaseous Combustibles:—Coal Gas and Coal Mine Explosions.—The Action of Coal Dust, etc., when Suspended in Air.

(Illustrative Cases, page 181.)

Certain mineral and organic bodies possess extreme inflammability, whilst a few have been known to fire spontaneously.

The medical jurist may be consulted in such cases as the following:—

(1.) Where a person charged with incendiarism alleges the fire to be the result of natural spontaneous combustion. (*Case* 7, etc.)

(2.) Where cargoes and ships have been consumed by the alleged spontaneous ignition of their contents. (Marine insurance.) (*Case* 3, etc.)

(3.) Where life and property have suffered from the ignition of certain accumulations on adjoining premises, or are endangered by contiguity to such inflammable materials. (*Case* 15, etc.)

(4.) Where spontaneous combustion of the human body is the alleged cause of death. (*Case* 26, etc.)

(5.) Lastly, a scientific inquiry may be called for, respecting the cause of special explosions, and the means to be adopted to prevent their recurrence.

The 38th and 39th Vict. (1875), cap. XVII. (called the Explosive Act), regulates all matters relating to the manufacture, sale, and storage of *explosives*. This latter term is made to include "gunpowder, nitro-

glycerine, dynamite, gun-cotton, blasting powder, fulminate of mercury and other metals, colored fires, and every other substance used or manufactured with a view to produce a practical effect by explosion or a pyrotechnic effect." It also includes "fog signals, fireworks, fuzes, rockets, percussion caps, detonators, cartridges, ammunition of all descriptions, etc."

Injuries to persons by the use of explosives is dealt with by the 24th and 25th Vict., cap. C., secs. 28 to 30, and injury to property by 24 and 25 Vict., cap. XCVII., secs. 9, 10, 45, 46, 54, 55. The prevention of the use of dynamite in fishery is provided for by 40 and 41 Vict., cap. LXV., and 41 and 42 Vict., cap. XXXIX., sec. 12. The keeping explosives for sale or in quantity (30 lbs. of gunpowder being all that is allowed by 38 Vict., cap. XVII., sec. 5, to be kept for private use) is regulated by license granted by the local authorities named for this purpose in the Act.

The Acts referring to petroleum are referred to on page 167.

A.—Solid Combustibles, Etc.

(1.) *Spontaneous Ignition of Coal.* (*Cases* 3 and 4.)—This was the subject of a report by Abel and Percy (Royal Commission, August, 1876). It has long been known that certain varieties of coal (more especially Welsh and Yorkshire coal) will, at times, fire spontaneously under conditions attendant on storage and transport, such as its breakage into small lumps, its being packed in a damp state and in a close place, etc. This is brought about by the spontaneous oxidation of the iron pyrites, present more or less in all coal—a compound, it is worthy of note, which varies considerably in its liability to undergo oxidation. The presence of moisture (and in this respect salt water is as effective as fresh) may assist oxidation by aiding the actual contact of oxygen with the iron sulphide. Not only may the oxygen of the air surrounding the coal, itself act on the pyrites, but the danger is intensified from the circumstance that freshly broken coal is specially liable to absorb oxygen. (Richter.) In this latter case it is evident that although moisture would aid combustion, it would at the same time help to limit oxidation by occupying the pores in the coal through which the pyrites is disseminated. "Spontaneous oxidation of pyrites by the oxygen absorbed from the air is therefore satisfactorily established, and is unquestionably one, if not the chief cause of the spontaneous heating of coal."

The oxidation of the iron sulphide develops heat. This increasing

day by day, in time reaches a point sufficient to ignite the inflammable constituents of the minerals through which it is distributed.

In lading coals it is manifestly important, therefore, *first*, to keep them dry, and, *secondly*, to prevent their being much broken. All coal contains a certain quantity of occluded marsh gas. From large lumps this may be given off in comparatively small quantity only. The danger of breaking the coal into small pieces is threefold—*first*, the quantity of marsh gas evolved is likely to be greater; *secondly*, fresh surfaces absorb oxygen with special activity; and *thirdly*, the smaller the pieces, the greater the absorbing surface exposed.

The advantage of ventilating the place where the coal is stored in such case is questionable, seeing that the admixture of air and marsh gas forms an explosive mixture, and that the supply of fresh air is practically the supply of the fuel required by the pyrites for its oxidation. Thus drawing air into the body of the freight manifestly might intensify, rather than lessen the mischief. The only possible advantage of ventilation would be to keep down the heat developed by chemical combination. How far this can be done effectually in a vessel containing no special apparatus for maintaining a constant current is doubtful. If ventilation does not keep the coal cool, it must do actual harm. And the opinion of the Commissioners seems to be, that it is unadvisable to attempt through ventilation in coal-laden ships.

(2.) *The Slaking of Lime.*—When water is poured on lime (CaO), a hydrate is formed (CaO, H_2O), great heat being evolved during combination. This union of the lime and water constitutes the operation of "*slaking*." The heat evolved by the process may be sufficient to fire combustible bodies placed in contact with it. Thus a wooden cart has been known to fire from a shower of rain wetting the lime with which it was filled.

(3.) *Lampblack*, more particularly when mixed with a certain proportion of oily matter, appears prone to spontaneous combustion. (*Cases* 1, 2, and 10.)

M. Aubert ("*Annales de Chimie*," 1831) has drawn attention to the fact that recently prepared charcoal, free from oil, when in a state of fine division, is prone to develop great heat, and to ignite spontaneously. The same fact has also been observed by M. Chevallier ("*Ann. d'Hyg.*," 1841, I., 339) and by M. Robin. It requires, however, according to Aubert, to be in masses of about sixty pounds for spontaneous inflammation to take place. The greatest heat was found to be in the centre, or about five or six inches below the surface, and it was here that ignition was remarked as occurring in the first instance.

(4.) *Sulphur* fires at from 450° to 500° F. (235° to 260° C.), the

precise temperature differing slightly according to the variety. Thus, the octahedral form fires somewhat below the prismatic. At any rate, sulphur is scarcely likely to fire spontaneously in any one of its allotropic modifications.

(5.) *Gunpowder* is a mixture of different proportions of sulphur, charcoal, and saltpetre. The *grain* or size of the powder varies with the purpose for which it is used. Service powder is classified according to the size of the grain, the letters L.G., F.G., R.L.G., R.F.G., signifying large grain, fine grain, large rifle grain, fine rifle grain, etc., etc.

If gunpowder be heaped up in the open air and inflamed, it detonates with but little report. If a small quantity be placed loose in a room and inflamed, it merely blows out the windows; but if the same quantity be confined in a bomb and fired, it may blow up the whole house. Thus the injury resulting from gunpowder explosions depends more on the method of firing than on the quantity fired.

Gunpowder shows no tendency to spontaneous heating. It requires a temperature of at least 520° F. (271.1° C.) for ignition. Thus a black heat or even friction would be sufficient to effect combustion. The smallest particle heated to the firing point is enough to explode any quantity of powder. Not a few of the accidents that have happened have no doubt been due to ignorance or carelessness.

The colors of fireworks are due to the presence of strontia, baryta, antimony, and other metallic compounds, which do not, except in the case of the strontia salt used in preparing red fire, sensibly increase the danger of the powder. Taylor records a case of the spontaneous ignition of red fire.

The force of the explosion in cartridge factories usually causes severe compound fractures, death commonly resulting from pulmonary complications ("*British Med. Journal*," 1870, II., pp. 667, 690).

(6.) *Gun-cotton* or *Pyroxylin* ($C_6H_7(NO_2)_3O_5$) is made by steeping cotton-wool in a mixture of sulphuric and fuming nitric acids. When the cotton after emersion is thoroughly washed, and dried at a gentle heat, it is found to have increased about 70 per cent. in weight, and to have become highly explosive, taking fire at a temperature of about 300° F. (149° C.), and burning without smoke or residue. This constitutes the gun-cotton of Schönbein. It possesses about four times the explosive power of gunpowder. Several varieties are known, distinguished by their different degrees of stability, and by their different solubilities in alcohol, ether, and other liquids.

Gun-cotton properly prepared (that is, where the acids employed in its preparation have been thoroughly washed out) is a fairly stable

body. On the other hand, if the acids used be not removed, but allowed to remain in contact with the cotton, it may undergo spontaneous ignition. (*Case* 22.)

Paper, sawdust, starch, and other bodies similarly treated, are also highly combustible. A prepared sawdust has been suggested for the use of sportsmen in place of gunpowder.

(7.) *Phosphorus* volatilizes at ordinary temperatures, and melts (firing when melted directly its surface is touched) at about 111.2° F. (44° C.). Dr. Taylor states that he has known phosphorus melt and fire spontaneously when touched, in a room the temperature of which was below 70° F. (= 21.1° C.). The ordinary lucifer-match composition fires at about 120° F. (48.8° C.), although varieties of make show in this respect marked differences. Hence large quantities of matches may fire spontaneously in summer. Red or allotropic phosphorus (used in most of the best matches) requires a heat of 600.8° F. (316° C.) to fire, but when mixed with potassic chlorate or nitrate, the mixture ignites at from 159° to 200° F. (70.5° to 93.3° C.).

Phosphorus dissolves freely in carbon disulphide, forming the liquid known as "Greek fire." If the solution be exposed to the air, the solvent rapidly evaporates, leaving the phosphorus in a finely divided state, and in a condition in which it speedily inflames. It must be noted, however, that the flames produced by phosphorus, do not, as a rule spread or burn the material upon which it is placed beyond the precise spot on which it rests. This is due to the large quantity of phosphoric acid generated during combustion, glazing as it were with a non-combustible varnish the parts in the vicinity of the burning phosphorus. Of course if the material on which the solution is poured is itself highly combustible, or if the flames come into contact with other combustible bodies in the vicinity, the fire would then spread as usual.

(8.) *Dynamite* was patented by A. Nobel in 1867. As first manufactured, it consisted of a siliceous earth of a porous and absorbent nature, obtained from Oberlohe in Hanover (*Kieselguhr*), impregnated with 75 per cent. of nitro-glycerine. Various substitutes for this siliceous earth, such as charcoal, sand, and sawdust, have been adopted. The dynamite prepared at Paris during the recent siege consisted of 25 per cent. of nitro-glycerine and 75 per cent. of a burned clay obtained from the glass and brick furnaces. Dynamite remains unchanged for any length of time. Thrown into a fire it burns with a bright flame, but without explosion. Its explosive power is reckoned to be about eight times that of gunpowder. It is superior to blasting-powder in mines, because it is not affected by damp, is more economi-

cal, and gives off no smoke. From its great disruptive power, the wounds caused by it are usually rugged and severe. (*Case* 21.)

(9.) *Metallic and other Combustible and Explosive Compounds.*—(*a.*) *Silver fulminate* ($Ag_2Cy_2O_2$) is prepared by dissolving forty or fifty grains of silver in about three-quarters of an ounce by measure of nitric acid (sp. gr. 1.37) with the aid of heat. To the hot acid solution two measured ounces of alcohol are added, and heat applied until reaction commences.

The silver fulminate slowly separates in the form of small, brilliant, white crystalline plates, which may be washed with a little cold water, and dried cautiously in a warm place. It is soluble in thirty-six parts of boiling water, but nearly the whole crystallizes out on cooling. It explodes when heated, or when struck with a hard body, or when touched with concentrated sulphuric acid, the metal being reduced and a large volume of gaseous matter liberated.

(*b.*) *Berthollet's fulminating silver* (Ag_3N) is formed by digesting silver oxide in ammonia. While moist it explodes when rubbed with a hard body, but when dry the touch of a feather is sufficient to fire it.

(*c.*) The *oxide* and *oxalate of silver*, and some other silver and mercury salts, are liable to explode with considerable force. The silver oxide is particularly prone to explode, when prepared from the nitrate by precipitation with ammonia.

(*d.*) *A silver potassium fulminate* ($AgKCy_2O_2$) is also known. Corresponding sodium and ammonium compounds exist. They all detonate if subjected to a blow or to friction.

(*e.*) *Mercuric fulminate* ($Hg''C_2N_2O_2$) is prepared by a process very similar to that adopted in the preparation of the silver fulminate, and its properties are also similar. It explodes violently by friction or percussion, but, unlike the silver salt, merely burns with a sudden and almost noiseless flash when fired in the open air. It is manufactured on a large scale for charging *percussion caps.* For this purpose sulphur and potassic chlorate, or more often potassic nitrate, are incorporated with it, and the mixture, pressed into the cap, is secured by a drop of varnish.

Abel mentions the circumstance that dampness of the fulminates may aid explosion by promoting chemism. He further mentions that *signal light composition* has been known to undergo decomposition (so that it would ultimately have exploded) from a little acid in the paper linings of the cases in which it was packed (the acid being derived from the antichlor used in the manufacture of the paper), setting up chemical action between the orpiment and the potassic nitrate. (For the

History of Detonating Agents, see Prof. Abel's papers in the "*Pharmaceutical Journal*," Vol. X. (3d series), pp. 26, 47, 69, 86.)

(*f.*) *Aurum fulminans* [which Beckman, in his "*History of Inventions*," says was known to the older alchemists] is said by Berzelius to have the composition of $Au_2O_3,4NH_3,H_2O$. It is formed by digesting auric oxide (Au_2O_3) in ammonia.

(*g.*) The *iodide of nitrogen* (NI_3) prepared by rubbing together iodine and strong ammonia solution, and *chloride of nitrogen* (NCl_3) prepared by placing a jar of chlorine over a solution of ammonic chloride, are very dangerous and explosive compounds. Chloride of nitrogen explodes between 199.4° and 221° F. (93° and 105° C.) with fearful violence. It is a deep yellow, volatile liquid. It has a sp. gr. of 1.653. Contact with almost any combustible matter, such as oil or fat, determines its explosion at common temperatures.

(*h.*) Explosions have many times been reported as arising from the many curious combinations ordered by physicians in prescriptions.

In the "*New York Medical Record*" (Jan. 22, 1881), the following are mentioned as examples of explosive prescriptions:—

(1.) Hypophosphite of lime, 50 centigrms.; potassic chlorate, 3 grms. 75 centigrms.; lactate of iron, 30 centigrms.

(2.) Solution of glycerine, 8 grms.; chromic acid, 4 grms.

(3.) A mixture of potassic chlorate, tincture of perchloride of iron and glycerine.

(4.) Potassic chlorate mixed with catechu. [This, it is stated, has exploded in the mouth when used as a dentifrice, if great friction be employed.]

(5.) Pills of oxide of silver.

(6.) Pills composed of potassic permanganate and reduced iron. Also pills of antimonic sulphide and chlorate of soda.

(7.) It is stated that pills made of nitrate of silver and creosote, also of a mixture of nitrate of silver, extract of nux vomica, hydrochlorate of morphia, conserve of roses and extract of gentian, have proved explosive. ("*Med. Press and Circular*," 1874, I., p. 518.)

A general caution in the matter of prescriptions may be given, viz., to avoid mixing glycerine and substances easily reduced with such oxidizing agents as the chlorates and permanganates or with chromic and certain organic acids.

In battle the use of explosive bullets is not permitted. This frequently becomes a subject-matter for recrimination. The character of certain wounds, or the broken, distorted, and shattered condition of

the projectiles found in them, are the grounds upon which the allegations that the enemy has employed them in war are commonly based. As a fact, however, these conditions constitute no proof whatsoever of explosive bullets having been employed. ("*Med. Times and Gazette*," Dec. 9, 1871, p. 715.)

The spontaneous combustion of certain vegetable and animal substances under special conditions of storage demands consideration.

I. *The Spontaneous Combustion of perfectly dry Organic Substances.*

Dr. Taylor remarks that although it may be true, as Chevallier states ("*Annales d'Hygiène*, 1841, I., pp. 276–309, and 1843, I., p. 99), that certain resinous woods, as pine, etc., or wood which has decayed and afterward been dried, if long exposed to a temperature above that of boiling water, become highly combustible, yet, on the other hand, it has never been proved that they will take fire below their igniting temperature in air, which is about 1000° F. (537.7° C.). Dr. Taylor says "he has exposed the thinnest deal shavings in contact with iron pipes at temperatures varying from 150° to 200° F. (65.5° to 93.3° C.) for some weeks without combustion, torrefaction, or any change approaching either condition. The most inflammable deal may be plunged into melted lead at 620° F. (326.6° C.) or into zinc at 770° F. (382.2° C.) without igniting. Dried wood, it is true, is in a condition to burn fiercely, but not to ignite spontaneously, or no dwelling-house, locomotive, or steam-vessel would be safe for a single day." (See Chevallier's paper for instances of supposed spontaneous combustion, in which the ignition of combustible substances was caused by the friction of wheels or by machinery.)

Many fires in houses, churches, workshops, etc., are due to stove-pipes, or to flues and chimneys being so fixed as to heat woodwork.

II. *The Spontaneous Ignition of Organic Substances Moistened with Water.*

An organic body that contains 50 or even 40 per cent. of water will not catch fire when held in a gas flame, nor will the application of a red hot iron do more than char it. A piece of jute or bast that contains 20 per cent. of water will ignite when held in a flame, but its combustion is not rapid. If, however, it contains 8 to 10 per cent. of

water, it then fires easily and burns rapidly. Hence for the spontaneous combustion of damp material to occur, the necessary conditions are—(α) that in some parts at least it must have dried to a considerable extent; and (β) that the heat generated must have been sufficient to ignite it. If hay, *e.g.*, be spread out it never fires, because a sufficiently high temperature to effect ignition is never reached. Its firing can only arise when it is closely packed in large bulk. Further, it would appear that there are no recorded cases where organic materials having been once thoroughly dried and afterward re-wetted, have fired spontaneously. Under these circumstances the tendency of such bodies is to decay (rot) rather than to eremacause.

The spontaneous combustion of organic bodies commences with slow burning (eremacausis of Liebig), the heat gradually increasing until at last actual ignition results.

(1.) *Vegetable substances:*—

(a.) Of the spontaneous combustion of *hay* when stacked in a damp condition numberless cases are recorded.

(β.) Of the spontaneous combustion of *raw cotton*, packed damp in the hold of a vessel, *Case* 5 is an illustration.

(γ.) Of the spontaneous combustion of *wet flax*, one doubtful case is recorded. ("*Ann. d'Hyg.*," 1841, I., 359.)

(δ.) Of the spontaneous firing of a barn loaded with *oats*, one case is recorded. (*Case* 17.)

We may presume similar results might occur in the case of barley, corn, etc., under conditions of a like kind. (See Chevallier, "*Ann. d'Hyg.*, 1841, I., 321, 323.)

(ϵ.) Of the spontaneous combustion of damp *esparto grass*, one case is recorded. (*Case* 16.)

(ζ.) Of the spontaneous ignition of damp *jute*, no case is recorded. The possible danger of storing this material, however, was the subject of a trial. (*Case* 15.) In this case, the heaps at most were only seven feet in thickness, and at a depth of six feet—that is, one foot from the ground—Dr. Taylor found the mass had a temperature of 117° F. (47.2° C.). The heap, moreover, was turned twice a week, and as soon as the material was dry, was removed from the premises. The conditions do not seem, therefore, to have been favorable to ignition. We can scarcely accept this case or the evidence of shippers, who said they had never known jute to undergo spontaneous combustion, as proof that it is an exception to the tolerably general rule applicable to bodies of a similar kind.

(η.) Of the spontaneous combustion either of heaps of damp *leaves*,

or of *manure*, no instance is recorded. Nevertheless, in the case of manure, a considerable temperature is often reached.

(θ.) Of the spontaneous combustion of *grain during malting*, no instance is recorded. The process of turning over and drying the barley before it is stored in any large bulk, is sufficient to explain the absence of such cases.

(ι.) There are no cases where the spontaneous ignition of *tobacco leaves* is recorded, although during manufacture they are stacked and undergo fermentation with the evolution of considerable heat (170° F. = 76.5° C.).

(κ.) Although no case is recorded of the spontaneous combustion of *cocoa-nut fibre* (coir) still there is evidence to show that considerable heat may result from packing cocoa-nuts in a damp state.

(2.) *Animal Substances:*—

(α.) A case of fire, believed to be due to the spontaneous ignition of *wool*, is on record. (*Case* 18.)

(β.) The spontaneous ignition of *silk* is also stated to have occurred. (*Case* 19.) In this instance the silk was said to have been dry.

III. *The Spontaneous Ignition of Organic Substances Moistened with Oil, etc.*

A large number of substances become very disposed to fire spontaneously when moistened with animal and vegetable oils. Mineral oils do not only not increase the spontaneous inflammability of organic bodies, but destroy the property that animal and vegetable oils confer on organic bodies in promoting their spontaneous firing. Such animal and vegetable oils, especially if drying oils, are not only themselves inflammable, but powerfully aid the absorption of oxygen.

Cases 6, 7, and 8 illustrate the spontaneous inflammability of *cotton* impregnated with oil. The cotton waste used for cleaning lamps and machinery has frequently fired spontaneously.

In *Case* 8 the question was raised, *what is oily waste?* The plaintiff contended that all cotton contained a certain amount of oil. It was decided that in insurance policies where it is stipulated that oily waste should not be in the stock, that it applied to the railway and foundry waste, such as is generally employed for cleaning machines.

Mr. Galletly ("*Pharmaceutical Journal*," September, 1872, p. 225) has experimented with various oils mixed with cotton waste, to

determine the time required to effect their spontaneous ignition. With seal oil, one hundred minutes only, and with boiled linseed oil, less than two hours, were required, whilst with lard oil, four hours were needed; with olive oil, five or six hours; with rape oil, ten hours; and with castor oil, two days. Sperm oil did not even char the cotton waste.

As regards greasy rags, Dr. Taylor says the heat is not likely to reach 1000° F. (537.7° C.), unless *large* quantities are accumulated. The author knows, however, of an instance in a private surgery, where there was no reason to suspect any one of arson, in which the contents of a drawer, consisting merely of a few greasy woollen and cotton rags, ignited.

Several fires occurred in warehouses on shore and in the Russian navy toward the close of the last century, which were at the time attributed to the acts of incendiaries. It was subsequently discovered that they arose from the spontaneous ignition of large quantities of flax, jute, and hemp impregnated with oil or grease. Experiments were made by the Imperial Academy of Sciences, and the result was to satisfy the inquirers of the possibility of spontaneous combustion under such conditions. (Paris and Fonblanque's "*Medical Jurisprudence*," Vol. I., p. 410. *See* also the "*Ann. d'Hygiène*," 1841, I., 364.) The great fire in Plymouth Dockyard in 1840, says Dr. Taylor, was supposed to have originated from a similar cause, though some attributed it to design.

In *Case* 9 *sawdust*, impregnated with oil, fired spontaneously.

In *Case* 10 a mixture of *boiled oil* and *lampblack* spread on *sailcloth*, ignited spontaneously.

In *Case* 11, the combustion of woody matters saturated with *cocoanut oil* is recorded.

In *Case* 12 *jute*, impregnated with *castor oil*, fired spontaneously.

A series of experiments are recorded in the "*Ann. d'Hyg.*," 1841, I., pp. 370–373, to show the extreme inflammability of various vegetable structures after having been boiled in oil.

In *Cases* 13 and 14, the spontaneous ignition resulting from the impregnation of vegetable structures with turpentine, is recorded. Mr. Scanlan ("*Records of Science*," August, 1835) found that woody fibre impregnated with turpentine, is liable to spontaneous ignition. Dr. Taylor gives one or two instances of ships apparently destroyed from this cause.

Cases of so-called spontaneous ignition, need in all cases very careful investigation. Admitting the possibility of the spontaneous ignition of various bodies, there are many reasons apart from questions of

science, that raise doubts respecting the occurrence of spontaneous combustion in the case of large fires, such for instance as that of London Bridge in 1861, attributed to the spontaneous combustion of jute. In the conflagration occurring at the City Flour Mills in Thames Street (November, 1872), Captain Shaw stated that although the fire was supposed to have originated in the heating of damp sacks, several of these were burned on the *outside* only, and not in the middle It was also found that a number of idle persons were on the premises the same afternoon, and that one of them, who had a box of lucifer matches, was intoxicated.

In investigating such cases—

(1.) We must not mistake the evolution of aqueous vapor for the smoke of combustion.

(2.) We must test whether carbonic acid is being evolved in considerable quantity.

(3.) We must determine the precise temperature at different depths. [In real cases of spontaneous firing the more central we get, the greater will be the temperature.]

(4.) We must examine whether the middle or outer parts show the most marked charring and blackening.

(5.) We must inquire whether the mass has been noticed to smoke for some days, increasingly.

It will be evident that the gist of these inquiries is to determine whether the burning proceeds from the *surface* (when it is most likely due to external causes), or from the *centre* (when it will probably be due to spontaneous heating).

Spontaneous Combustion in the Human Body (*Cases* 26 to 33).

There is no subject in the whole range of Medical Jurisprudence on which so much romance has been built as this. Since 1692, when the subject was first seriously discussed, popular novelists have often embellished their works by the introduction of some such story, or amused themselves by telling or re-telling some of the current legends on the subject. The disappearance of the law-writer in Dickens' "Bleak House" is perhaps one of the best of these.

Writers on Medical Jurisprudence have treated the matter from different points of view. Some, like Beck, scarcely express any opinion on the subject. Others, like Casper, contemptuously reject it.

Others, again, as Taylor, combat the theory of spontaneous combustion in a more scientific spirit. On a careful consideration of the whole question, we have come to the conclusion :—

First, *That there is no authentic case of true "spontaneous" combustion of the human body on record.*

We do, however, find a considerable number of cases in which old and infirm persons, mostly spirit-drinkers, have met their death by fire, originating, it would appear, from an accidental spark setting their clothes alight. In many of these cases the combustion of the body was far more perfect than that of the clothes, or of surrounding inflammable substances. There appears, therefore, a strong probability that the bodies of spirit-drinkers are more combustible and more easily set on fire, than those of persons not addicted to alcohol. Nor indeed is this increased inflammability of a fat person saturated with spirit other than what we should expect from "a priori" reasoning. Hence we conclude :—

Secondly, *That there is evidence to show that the bodies of habitual drunkards, more especially if corpulent, are more than ordinarily inflammable, and hence that slight accidents, such as the upsetting of a candle, or a spark projected from the fire, might lead to the ignition of the body and its destruction by burning.*

The deductions of Drs. Lair and Marc apply to most of these cases. They say :—1. The majority of the sufferers were females either very *fat* or very *lean*, and advanced in life. 2. Most of them were addicted to spirits. 3. The combustion occurred accidentally, and often from a very slight cause. 4. The combustion was very rapid, usually consuming the entire trunk, whilst the extremities were left unhurt. 5. Water sometimes promoted, rather than checked, the combustion. 6. The fire seldom did much other damage, and often did not affect the combustible objects in contact with the body at the time it was burning. 7. There was left, as a residuum, fetid ashes, with an unctuous, stinking, and very penetrating soot. 8. These combustions are recorded as having occurred in all countries and at all seasons.

Most of the recorded cases, it must be admitted, are marred by a want of precision, or by an evident credulity on the part of those who relate them. And not a few of the supposed cases of spontaneous combustion turn out to be murders, in which the culprits hoped to conceal the traces of their crime by fire.

It has been suggested that phosphoretted hydrogen may be gener-

ated in the human body, and Professor Apjohn appears to favor this view. It is true that the gases found in dead bodies are sometimes inflammable. [" *Edinburgh Med. and Surgical Journal*," Vol. XXXVI., p. 221. (See Vol. I., p. 69.)] But it is a question whether they are likely to be present in sufficient quantity or purity to fire—in other words, whether they are not, as a rule, so diluted with non-combustible gases, that they cease to be liable to ignite.

It is evident that the weight of authority is not in favor of human spontaneous combustion. No one of any position or authority has ever seen a case, and the fact is certain that dead bodies burn slowly after being steeped for a long time in alcohol, or even when alcohol has been injected into the veins. (M. Chassagniol, " *Lond. Med. Rec.*," November 11, 1874.) On the other hand, the weight of authority supports the notion of the increased combustibility of bodies under certain conditions, and in such cases the possibility of accidental ignition.

B.—Liquid Combustibles.

By a combustible liquid is implied one that evolves vapor at a low temperature, the vapor igniting if a flame or hot body be applied to it. But because a combustible liquid emits vapor at a low temperature, it does not follow that the vapor is combustible at a low temperature. Thus, alcohol is a combustible liquid :—it boils at 173° F. (78.4° C.)—and the vapor is given off far below 173° F. Nevertheless, a temperature of 173° F. will not fire the vapor, a pale red heat at least being necessary for this purpose. Thus, we must distinguish between the volatility of a combustible liquid and the temperature at which its vapor fires. Combustible liquids are dangerous, because if but once a sufficient temperature be applied to the vapor to ignite it, even though the heat be at a distance, the flame rapidly travels down to the liquid from which the vapor is being disengaged. A constant and increasing evolution of inflammable vapor is thus kept agoing, until the whole of the liquid is vaporized and consumed.

By the 34 and 35 Vict. (1871), cap. CV. (designated An Act for the Safe Keeping of Petroleum), petroleum is made to include any rock oil, Rangoon oil, Burmah oil, oil made from petroleum, coal, schist, shale, peat, or other bituminous substance, and any products of petroleum, or any of the above-mentioned oils. These materials, by the Act of 1879, 42 and 43 Vict., cap. XLVII., sect. 2, must not evolve inflammable vapor below 73° F. (22.77° C.) when tested by a flash

test with a special form of apparatus described in the Act, and a model of which is deposited with the Board of Trade.

This does not mean, however, that the vapor is inflammable at this temperature, but only that the vapor, which would ignite if a flame or hot body were applied, is evolved at this temperature. The 44 and 45 Vict., cap. LXVIII., regulates the hawking of petroleum, limiting the quantity to be conveyed about on land by hawkers to 20 gallons.

The 1871 Act forbids the storage of petroleum, except by the license of the local authority, under a penalty of £20 per day. By sect. 7, however, 3 gallons may be kept for private use or for sale without license, provided it be stored in separate glass, earthenware, or metal vessels, securely stopped, not containing more than 1 pint each.

Petroleum explosions. (We include under the general name petroleum, all such liquids as naphtha, benzine, benzoline, gasoline, etc., etc.) The vapor of petroleum merely burns. In order to become explosive it must be mixed with a large bulk of air. Given conditions permitting volatilization of the spirit, and the admixture of the vapor with air, an explosive mixture is formed. Thus an explosion may result from a naked light being taken into warehouses or the holds of vessels where petroleum is stored, or more particularly into premises where the operation of transferring the liquid from one vessel to another is being, or has been, conducted. In the former case the accident may depend on leakage from the casks or barrels consequent on rough usage, or may arise from the evaporation or diffusion of the spirit through the pores of the wood. To prevent such evaporation occurring, the casks employed for petroleum are usually rinsed out with a solution of glue, and covered over in the storehouses after they are filled with tarpaulin. No doubt what was known as the "Regent's Park Accident" was due to the firing of a mixture of air and petroleum vapor in the cabin. (*Case* 25.) It is not improbable that many of these accidents have arisen from the presence in the oil of highly volatile ingredients, that should have been removed by distillation. The liquid known as *Xerotine siccative* consists of these highly volatile constituents of petroleum.

In 1875 an explosion is reported to have occurred in the sewer at Greenwich, owing to certain petroleum products finding their way into it. The explosive mixture of air and vapor must have been fired by a flame possibly dropped by a smoker through a sewer grating.

A question respecting the danger of fire arising from the accidental upsetting of petroleum and parffin lamps came before the courts in the case of Mason *v.* Nicholson. (See "*Daily Chronicle*," May 22, 1879, and following days.) The plaintiff, an artist, claimed £2,500 damages

of an Insurance Company, asserting that a lighted lamp, containing half a pint of Alexandra oil (petroleum) was upset accidentally over certain valuable paintings and engravings, nearly the whole of which were consumed as a consequence. A verdict was given for the Insurance Company (the defendants). In this case there were many points raised, that, according to the theory of the defence, threw some doubt on the genuineness of the fire. The plaintiff had had a previous fire of insured paintings, and the injury to the carpet and to the surrounding furniture in the present instance did not correspond with the extent of damage done to the drawings.

There are several circumstances that may be the cause of accidents with petroleum lamps. Thus if a lamp charged with a small quantity of petroleum spirit (for accidents rarely happen when a lamp is fairly well filled) be carried carelessly, the liquid may be brought into contact with heated portions of the burner, so that rapid volatilization takes place, and a considerable burst of flame results. Such an accident is specially liable to occur with the small metal lamps now so commonly sold, in which benzol is burnt. Serious results in such cases may follow if the lamp be dropped from fright, or if the ignited spirit be scattered from the reservoir of the lamp being broken by the sudden burst of vapor.

Again, these so-called petroleum explosions (for, in fact, these explosions are cases of ignition and not cases of explosion at all) may result from the use of a badly refined oil, the very volatile products present being set free at the temperature at which the reservoir becomes heated. In this manner a feebly explosive mixture with the air may be produced, which is ignited by the flame of the lamp. Although "the explosion" may amount to a mere puff, it not unfrequently cracks the reservoir.

Accidents from the falling over of lamps, however, are by no means so likely to occur as is commonly supposed. As a rule the mere shock of falling is sufficient to extinguish the flame but even supposing this not to occur, the oil running over the flame, will, in ninety-nine cases out of a hundred, extinguish it. The oil in a well-made lamp is rarely more than five degrees Fahr. above the outside temperature. Hence, supposing such an accident to happen, at any rate the oil must be some time, and even a considerable time, in contact with the flame in order that it may be heated to a temperature (say 120° F., or even higher) when vapor will be disengaged, below which the oil is as harmless as water. And further, the oil must not pour out in such quantity as to deluge the flame, otherwise it is certain to extinguish it. There is another point to be considered, moreover, which is that the interval, say

of two or three minutes, during which the oil is being heated sufficiently to generate the vapor, allows time for the flame to be extinguished almost by a blow from the mouth, but most certainly by covering it over with matting, or by sprinkling it with a little water.

The author conducted a series of experiments on a large scale in the case referred to. The results proved that for any serious accident to happen we must suppose:—

1. That the shock of falling does not extinguish the flame.
2. That the oil in pouring out of the lamp does not extinguish the flame.
3. That a sufficient interval elapses, during which the oil is in contact with the flame, to admit of its becoming so heated as to evolve combustible vapor in any quantity.

If, therefore, it be stated that immediately the lamp fell, the flames flared up, and the whole place was in a blaze, the story is, to say the least, excessively improbable. In the experiments conducted it was found that in a room of 30 ft. by 20 ft. we were unable, owing to the irritating nature of the products of combustion, to remain in the room more than ten minutes after the oil and furniture had caught a light.

Boiler Explosions.—An explosion commonly results from the sudden conversion of a solid or liquid into gas, and the further expansion of the gas by the heat.

The causes of boiler explosions are, as a rule, not difficult to find. Of these, the malconstruction of boilers, the corrosion and consequent thinning of the metal, some failure in the working of the apparatus which allows the escape of steam and warning of excessive pressure, etc., may be mentioned. But the most common cause of boiler explosions is undoubtedly the neglect of periodical cleaning and removal of the fur, consisting chiefly of earthy carbonates deposited from the water, which are insoluble in water deprived of its carbonic acid. To prevent this furring, various "boiler solutions," or "anti-fouling preparations" have been suggested. Those preparations should be avoided that themselves corrode the boiler. None, however, can safely be employed in kitchen boilers, the water of which is used for culinary purposes. Perhaps the fouling of boilers is best prevented by keeping a few oak staves constantly in the water. But again this method is scarcely applicable to water used in the kitchen.

The danger of fur in boilers arises from the circumstance that owing to the unequal expansion of the metal and the incrustation, the

latter will, from time to time, break away. In such case, the water suddenly comes into contact with the intensely heated metal of the boiler, whereby an enormous volume of gas or steam is instantly generated.

Nitro-glycerine (Glonoin, Nobel's blasting oil) [$C_3H_5(NO_3)_3$] (sp. gr. 1.6) is a yellow, oily liquid, insoluble in water but soluble in alcohol and ether. It is made by acting on glycerine with a mixture of three parts of sulphuric and one part of fuming nitric acid. This is poured into five or six times its bulk of cold water, when the nitro-glycerine sinks to the bottom. When violently struck, it explodes, being resolved into water, carbonic acid, nitrogen and nitrogen oxides. The volume of gas produced is about 10,000 times the initial volume of the nitro-glycerine. Its explosive force is about thirteen times that of gunpowder. If it has not been thoroughly washed, in other words, if a little acid has been allowed to remain, it may undergo decomposition and fire spontaneously. Thus its stability depends on the care taken in thoroughly removing the acids employed in its manufacture.

Bisulphide of Carbon (CS_2) boils at 110° F. (43.3° C.), but is volatile at common temperatures. The vapor fires at 360° F. (182.2° C.), and perhaps at even a lower temperature. ("*Chemical News*," Vol. VI., p. 4.) The vapor when mixed with air is explosive. The liquid is largely used in different manufactures. The concentrated sun's rays might be sufficient to fire the vapor if diffused in a factory, and so cause an explosion.

Alcohol [Ethylic alcohol, $C_2H_5(OH)$. Boiling point, 173° F. (78.4° C.)] is volatile at ordinary temperatures, but the vapor requires a high temperature for its ignition. The flame is non-luminous and smokeless.

Wood Spirit [(methylic alcohol; $CH_3(OH)$; pyroxylic spirit). Boiling point 151.7° F. (66.5° C.)] is also volatile at a low temperature, but the vapor requires at least a red heat for its ignition. It then burns with a pale-colored flame which deposits no soot.

Ether ($(C_2H_5)_2O$) is volatile at common temperatures. It boils at 96° F. (35.6° C.), but the vapor requires a red heat for ignition. It burns with a luminous flame. An explosion of a mixture of sulphuric acid and nitric ether prepared by a druggist as a button cleaner, has been stated to have occurred. ("*Med. Press and Circular*," May 25, 1881, p. 453.)

Turpentine ($C_{10}H_{16}$) boils at 320° F. (160° C.). The vapor requires a full red heat for ignition. Combustion results when the liquid is acted upon with fuming nitric acid.

Benzol (benzine) (C_6H_6) boils at 176.9° F. (80.5° C.). The vapor burns with a luminous flame, to fire which a full red heat is needed.

C.—Gaseous Combustibles.

Certain gases are spontaneously inflammable. Of these *phosphoretted hydrogen* or *phosphamine* (PH_3) [the spontaneous inflammability of which is due to the presence of a trace of liquid phosphoretted hydrogen (P_2H_4)], and *silicic hydride* (SiH_4) may be mentioned.

Pure *hydrogen* explodes with great violence when mixed in proper proportion with air or oxygen.

Coal Gas Explosions.[1]—Coal gas is an admixture of several gases. It requires almost actual flame (at least a white heat) for its ignition. If flame be applied to a pipe from which coal gas issues, or to a leaky spot in a gas holder, the gas would simply burn at the point of exit, just as the gas burns at a gas jet, and that is all. In other words, the flame would not be communicated to the whole bulk of the gas in the pipe or holder. The same result would happen even if the coal gas contained a small quantity of air. But if the coal gas be mixed with about seven to ten times its bulk of air, then a violent explosion would occur if a light was applied. The damage resulting from entering a room with a naked candle where there had been a leakage of gas, depends on the presence of an explosive mixture of gas and air. If, therefore, an explosion occurs in a gas main, or in a gas holder, it is certain that the explosive gas is not pure coal gas, but a mixture of coal gas with several times its bulk of air.

Gas explosions in houses, etc., are commonly due to defective fittings, such as imperfect ball-and-socket joints, leaky telescope slides, etc.

The Tottenham Court Road explosion (July, 1880) depended on the presence of an explosive mixture of gas and air, the latter having found its way into the gas pipe during repairs. The results of the explosion extended a considerable distance. Over twenty-five persons were injured.

In *Coal Mine Explosions* (*Case* 20) the explosive mixture (known by the name of *fire-damp*) is a compound of methane or light carburetted hydrogen (CH_4) and air. Mixed with seven times its volume of air, methane explodes violently when a naked flame or a white heat is applied, the violence gradually decreasing from this point until the air is about seventeen times the bulk of the methane, when the mixture ceases to be explosive. When the proportion is as 1 to 18 of air, the mixture merely forms a pale blue flame round the light (corpse light).

[1] See *Case* 24, a curious illustration of difficulty in framing an indictment, where a person was charged with causing injury to another by permitting an escape of gas.

Carbonic anhydride and water are the products of combustion, the former constituting the "*Choke Damp*" of the miner, to the poisonous action of which, no doubt, more of the fatal results of an explosion are due than to the explosion itself.

It has frequently happened that the sufferers from an explosion die of some brain complication. (*Case* 23.)

It has been suggested that in a coal mine explosion the cause of death is not so much asphyxia, as the swallowing red hot particles of coal suspended through the mine as one result of the explosion. Thus it is supposed that the victims are actually burnt to death, rather than suffocated. (See M. Riembault's paper to the Academy of Sciences, referred to in the "*British Med. Journal*," Jan. 31, 1880, p. 183.)

The usual method of detecting fire-damp in air is by observing the indications afforded by the flame of the safety-lamp. The safety-lamp, however, does not serve to indicate the presence of very small quantities of fire-damp, although it gives unmistakable results with large quantities. If, however, the flame of the lamp be exceedingly small, say not more than the $\frac{1}{8}$th of an inch high, the "cap" (that is the conical blue flame which appears to rest on the oil flame) becomes apparent, its size varying with the quantity of fire-damp present in the air. It is assumed if there be no "cap" that there is no fire-damp, but this is by no means necessarily the case.

Mr. Galloway's experiments show that the cap varies in different mixtures of air and fire-damp as follows:—

Composition.	Appearance of Cap.
1 fire-damp to 16 air	Voluminous, waving, spindle-shaped, $3\frac{3}{8}$ ins. high.
1 " to 18 "	2 inches high.
1 " to 20 "	$1\frac{5}{16}$ in. high. Very steady and pointed.
1 " to 25 "	$\frac{1}{2}$ to $\frac{5}{8}$ in. high. Conical.
1 " to 30 "	$\frac{3}{16}$ to $\frac{1}{4}$ in. high. Conical.
1 " to 50 "	$\frac{1}{8}$ in. high. Very faint, and apparently broken off at top.
1 " to 60 "	Existence of cap doubtful.

This last atmosphere most miners consider safe, and the quantity of marsh gas present unimportant. At any rate, safe or not safe, it is the limit of impurity which the safety-lamp indicates.

The influence of coal dust in producing an explosive mixture with air has received considerable attention, and has been the subject of experiments and memoirs by Faraday and Lyell in 1845, by M. Verpilleux in 1867, by Mr. Galloway (Proceedings of the Royal Society,

March 2, 1876, March 13, 1879, and June 16, 1881), by Mr. Abel ("*Report on Samples of Dust collected at Seaham Colliery*," July, 1881), and by M. Vital ("*Annales des Mines*," 1875).

In Mr. Galloway's first paper he draws attention to the fact that a mixture of air with finely divided combustible solids (such as flour) is explosive, more especially if it be fired in a confined space. In a coal mine, layers of rubbish, consisting of dry coal dust, or of coal dust mixed with pieces of coal and stone, are found on all the floors of the air-ways. Mr. Galloway contends that the presence of an explosive mixture of air and coal dust is the explanation of many explosions occurring in places where at any rate no large accumulation of fire-damp existed. A gust of wind (originated, possibly, by the explosion of a small accumulation of fire-damp), or a blasting operation (and it is certain that coal-mine explosions have increased since gunpowder has been used for breaking the coal), would be amply sufficient to raise the dust cloud. And the results follow in order, "the flame of the original inflammable mixture would pass directly into the newly formed one, expanding its volume; the disturbance would be propagated over an ever-widening area, until that area might possibly become coextensive with the workings themselves: and the consequences would be the same as if the whole space had been filled with an inflammable mixture before the disturbance began." That this may be so, seems possible from the accounts of the Campagnac Colliery explosion (November 2, 1874), where no fire-damp was detected. A shot fired in the mine seems to have disturbed the coal dust, and the explosion occurred immediately afterward. Thus the coal dust in a well-ventilated mine may itself be a cause of danger, or where fire-damp already exists, may increase the chances of explosion or aggravate the consequences.

Mr. Galloway's experiments prove that a mixture of air and coal dust is not inflammable at ordinary pressure and temperature, but that it becomes so when mixed with a small quantity of fire-damp, *i.e.*, a quantity less than is indicated by the safety-lamp. Mr. Galloway describes his inspection of the New Tredegar Colliery after the explosion on December 4, 1875. The results of his inquiries in this case were that the whole of the air of the mine contained some fire-damp, and that an explosive mixture had fired from a naked light at the inner end of the level. Further, he considers that the explosion of the mixed gas raised a cloud of coal dust, which when mixed with a little fire-damp and air, formed an explosive mixture such as would not have resulted had no coal dust been present. In this manner the evil of the first explosion was rendered more extensive.

What then is the smallest quantity of fire-damp necessary to make air explosive when coal dust is present? Mr. Galloway's experiments indicate that if air contains 0.892 per cent. of its volume of fire-damp, it is capable of forming an inflammable mixture with coal dust. If the proportion of fire-damp present be greater, the explosive power increases until a maximum is reached, after which it begins to decline. But Mr. Galloway contends that a mixture of coal dust and pure air is so nearly inflammable, that it would probably become explosive when it undergoes the compression and consequent heating which the occurrence of an explosion in one part of a confined space must necessarily produce throughout the remainder of the same space.

Mr. Galloway states that some kinds of coal dust require less fire-damp than others to render the air inflammable, and that it is, therefore, conceivable that still other kinds of coal dust may form inflammable mixtures with pure air. No doubt, however, the presence of a small quantity of fire-damp is required to create the first disturbance.

As regards the quantity of coal dust required to render the air explosive, Mr. Galloway considers one ounce of coal dust to a cubic foot of air to be necessary. In some cases the air, he states, had to be black with dust before it would ignite. Thus he is of opinion that the particles normally floating about the air of a dry mine would not render it inflammable, but that a gust of wind would raise sufficient dust for the purpose.

Abel, from his experiments in the Seaham case, is of opinion "that a minute quantity of dust may under favorable conditions serve as the inciting cause of the ignition of fire-damp mixtures of such a nature, that, in the absence of that cause, they would escape ignition."

M. Vital explains these curious results by supposing that portions of the coal dust are successively decomposed, the products yielding explosive mixtures with the air, the violence of the burning being much influenced by the fineness of the dust.

Abel's experiments show, however, that in its power to bring about the ignition of an otherwise uninflammable mixture, magnesia, silica, slate dust, etc., are but little inferior in this respect to the most inflammable samples of coal dust.

It has been shown that one volume of fire-damp in sixty volumes of air is the smallest admixture that the safety-lamp (the usual test employed) will indicate. It has further been shown that one part of fire-damp mixed with 112 of air becomes inflammable at ordinary pressure and temperature, when charged with fine *dry* coal dust. Thus it is evident that an explosion originated in any way whatever may

extend itself to remote parts of the workings where the presence of fire-damp was unsuspected.

The phrase "*dry* coal dust" calls for this remark. The hygrometric condition of coal dust is influenced materially by the quantity of aqueous vapor in the air. Hence explosions from mixtures of air and coal dust are more likely to occur when the air is at its *driest*, because the dust rises more easily and burns more actively. Mr. Galloway further contends that "explosions whose magnitude is due to the influence of coal dust will happen most frequently during cold weather; and conversely . . . that the magnitude of those explosions which occur during cold weather is traceable in some measure to the influence of coal dust."

Much, it is certain, will depend on the comparative wetness or dryness of a mine;—and dryness or wetness is greatly dependent on depth. A coal mine not more than 400 feet deep is usually damp and wet, whilst one of 700 feet deep is usually dry and dusty. Between these points much depends on the temperature of the air that finds access to the mine.

If there be much smoke and soot produced, with the ejection of large bodies of dust from the shaft—or if the timbers exhibit a charred appearance from a deposit of coked coal dust on their surfaces—or if the sides of the galleries are found to be on fire immediately after the explosion, we may then conclude that coal dust has played an important part in the accident.

The following are the principal conclusions among those deduced by Professor Abel from his numerous experiments on the dust drawn from the Seaham Colliery:—

6. The several samples of dust differed from each other considerably in sensitiveness, *i.e.*, in the readiness with which they promoted the ignition of a mixture of air and fire-damp, in such proportions that it was not inflammable *per se* when brought into contact with the flame of a lamp, or in regard to the proportion of fire-damp required by the several samples to impart explosive properties to them, when suspended in air.

7. The most sensitive of the Seaham dusts were found to be those which were the richest in coal, and those which also contained the highest proportions of very fine dust.

8. Comparing the samples of Seaham dust with dust obtained from other collieries where disastrous explosions have recently occurred, it was found that the most sensitive of the former was somewhat less sensitive than samples of dust obtained from Leycett Colliery (Fair Lady Pit), which ranked highest in this respect among all the samples experimented with. The Leycett dusts corresponded closely in chemical character and

specific gravity to the purest Seaham coal dust; their somewhat greater sensitiveness was perhaps ascribable to their remaining more uniformly suspended in air currents, but possibly also to physical peculiarities.

9. One of the Seaham dusts which ranked high (third) in order of sensitiveness contained the lowest proportion of coal of all the samples, and consisted of non-combustible matter to the extent of nearly half its weight.

10. Special experiments, which were instituted in consequence of the behavior of this sample, demonstrated that some perfectly non-combustible powders, which are also not susceptible of any chemical change when exposed to the action of flame, are very little inferior to the most inflammable or sensitive of the Seaham dust samples in their power to bring about the ignition of an otherwise uninflammable mixture of fire-damp and air.

11. Mixtures of fire-damp and air, in proportions bordering on those which will ignite on the approach of flame, are inflamed instantaneouly if they contain in suspension only few particles of such non-combustible dusts, or of the Seaham or other dusts from coal-pits.

12. This effect appears ascribable, at any rate, in part, to the fact that these dust particles, when they pass through a lamp-flame, immediately become incandescent, and thereby localize and intensify the heat at those points, and thus bring about the ignition of the mixture of air and fire-damp by which they are surrounded. But some phenomena observed in the course of the experiments with non-combustible powders favor the belief that finely divided solids of particular descriptions may exert another quite distinct kind of action when heated in fire-damp mixtures, which may at least contribute importantly in determining the ignition of gas-mixtures which are not susceptible of inflammation by the application of flame alone. This subject is about to receive complete investigation.

13. The smallest proportion of the fire-damp experimented with (from the 9-foot Wigan mine) which became ignited and produced explosive effects, when passing a naked lamp-flame at a velocity of 600 feet per minute, by having suspended in it the most sensitive of the Seaham dusts, was 2.5 per cent. The most sensitive coal dust from Leycett furnished a mixture which exploded when passing the flame, under corresponding condition, with air containing only 2 per cent. of fire-damp. A mixture of 2.75 per cent. of fire-damp with air was ignited by the lamp through the agency of a perfectly non-combustible powder (calcined magnesia).

In a current moving at a velocity of only 100 feet per minute, the Leycett coal dust, suspended in air containing only 1.5 per cent. of fire-damp, became ignited by the lamp-flame, the ignition extending throughout the mixture.

14. The accidental presence of a proportion of fire-damp, which must have been considerably below the smallest above specified, caused one of the most inflammable of the coal dusts (from Leycett) to become inflamed

and to carry fire some distance, when a small powder-charge was fired from a cannon while the dust was travelling.

15. The sensitiveness to ignition of a mixture of air with a small proportion of fire-damp is considerably increased if the source of heat is increased.

16. The results of the experiments with Seaham and other dusts appear to have demonstrated—

(*a.*) That coal dust in mines not only much promotes and extends explosions in mines by reason of the rapid inflammability of the finely divided combustible, and of the readiness with which it becomes and remains suspended in air-currents; but

(*b.*) That it may also be itself readily brought into operation as a fiercely burning agent which will carry flame rapidly as far as its mixture with air extends, and will operate even as an exploding agent, *through the medium of a proportion of fire-damp in the air of the mine, the existence of which, in the absence of the dust, would not be attended by any danger.*

(*c.*) That dust in coal mines, *quite apart from any inflammability which it may possess*, can operate in a distinct manner, as a finely divided solid, in determining the ignition of mixtures of only small proportions of fire-damp and air, and consequently in developing explosive effects.

(*d.*) That a particular dust in a mine (such as the Seaham N dust) may therefore be a source of danger, even though it contains only a small proportion of coal or combustible matter. Although the explosion which may occur through the agency even of a non-combustible powder, in the manner described, may be of a very mild or feeble character in the first instance, it may be almost at once increased in magnitude and violence by coal dust which the first ignition will raise and bring into action.

17. The proportion of fire-damp required to bring dust in a mine into operation as a rapidly burning or exploding agent, even on a small scale, and with the application of a small source of heat or flame, is below the smallest amount which can be detected in the air of a mine, even by the most experienced observer, with the means at present in use, as has been already demonstrated by the experiments of Mr. Galloway. Indeed, with dusts of highly sensitive or dangerous character, under those conditions, and very possibly with dusts not more so than the least sensitive of the Seaham samples, *in the presence of a source of considerable heat and flame*, such as a blown-out shot or an overcharged hole would constitute, a small proportion of fire-damp, the possible existence of which in the mine might

not be in the least suspected, may serve as the inciting cause to the development of an explosion of coal dust.

18. In the complete absence of fire-damp coal dust exhibits some tendency to become inflamed when passing a very large lamp-flame at a high velocity; if exposed to the action of a large volume of flame, such as is produced by the explosion of freely exposed gunpowder or gun-cotton, it exhibits, in addition, a decided tendency to carry or propagate flame. But, so far as can be determined by experiments on a moderate scale, this *tendency* (which was exhibited by Seaham X, K, and S dusts, and still more by the more sensitive Leycett dust) is of limited nature, and very different indeed from the *property* of carrying or propagating flame, which even comparatively non-sensitive dusts possess, *in the presence of a very small quantity of fire-damp.*

In conclusion, it may be admitted as possible that, with the large volume of flame, and the great disturbing effect, of a blown-out shot, as the initiatory cause of the ignition of dust, and its suspension in the surrounding air, such inflammation may, in the complete absence of fire-damp, be propagated to a greater distance than the results of small experiments would warrant one in assuming. But it can scarcely be maintained that the air of a mine in which the coal gives off gas at all can be, at any time, *free* from fire-damp; and as the existence of very small and unsuspected quantities of that gas in the air of the mine may suffice to bring about the ready propagation of flame by coal dust, and thus to develop violent explosive effects, it would appear needless to assume that coal dust may, in the entire absence of fire-damp, give rise to explosions, even of only limited character in coal mines, in order to account for casualties which cannot be ascribed to the existence of accumulations or sudden outbursts of fire-damp.

Experiments on this subject are being made at Harton Colliery, and also at Chesterfield by a Committee of the Chesterfield and Derbyshire Institute of Engineers. The experiments of the Chesterfield Committee confirm (it is stated) the view that flame will travel in a mixture of coal dust and air, even in the absence of a trace of fire-damp.

The practical conclusion suggested by these facts is, the advisability of removing from the mine as far as possible all dust liable to be disturbed by the passage of men and horses and by every puff of air, and to water the roadways. There is no little difficulty, however, in reducing to practice regulations that look well on paper.

Explosions in Flour Mills, etc.—It has been proved beyond question that a mixture of air and fine flour dust is inflammable. From the friction of the millstones igniting a mixture of this description, the

Glasgow Flour Mills were completely destroyed (July 9th, 1872), the flame rapidly spreading through the conduits leading to the exhaust box on the upper floor.

Some care is necessary in flour mills to prevent such accidents. The exhaust should be placed outside the building, and should offer as little resistance as possible to sudden expansion, resulting from the ignition of inflammable mixtures. And again, the conduits leading from the mills to the exhaust chambers should be small, and there should be no other communication between the interior of the building and the dust receptacles.

An explosion in a candy factory in New York, resulting in the loss of twelve lives and the destruction of the building, is recorded. A large quantity of starch is used in the preparation of the moulds, and the explosion is supposed to have arisen from the atmosphere of the factory becoming charged with the fine starch powder. A similar accident is said to have occurred in a linoleum factory, through the ignition of cork dust diffused through the building. ("*Lancet*," March 30, 1878, p. 481.)

ILLUSTRATIVE CASES.

1. **Ann. d'Hyg., 1841, I., p. 343.**—("Taylor," Vol. I., p. 709.)—Six weeks after a vessel, laden with casks of lampblack, had left Portsmouth, signs of smoke and a smell of burning issuing from one of the casks was remarked. The cask was intensely hot, but not in flames. Other casks were also observed to be smoking. The whole were thrown into the sea. The casks were surrounded by barrels of tar and jars of oil, and there was some reason to suspect leakage from these had occurred. No light had been taken into the hold since the vessel had left England. (Page 156.)

2. **Taylor's Med. Juris., I., p. 709.**—A fire said to have occurred at Doncaster Railway Station from the spontaneous combustion of lampblack. (Page 156.)

3. **Michael v. Gillespy.**—(*C. P.*, 1856.)—Plaintiff agreed to convey a cargo of coals from the Tyne to Aden, and insured the freight in a time policy for £300. The ship leaked whilst in the Tyne, but the leak was at once stopped. The vessel encountered a storm, and put into Cuxhaven. The coals were here landed, and found to be much wetted with salt water. The captain was advised, considering the state of the coals, not to reship them, for fear they might ignite spontaneously. A claim was then lodged for a total loss of freight. The defendants contended that the owner knew the vessel was leaky;—that the cargo was not lost by the perils of the sea;—that the coals might have been reshipped without danger;—and that if they had been washed with fresh water and dried, there would have been no fear of spontaneous ignition. Verdict for plaintiff. (Pages 154, 155.)

4. **Taylor's Med. Juris., I., p. 710, 1859.**—A cargo of 640 tons of coal, shipped at Hartlepool, became wetted with sea water. For fear of spontaneous combustion they were landed at Lowestoft, and a claim made for loss of cargo. They were found to contain iron pyrites that were undergoing disintegration. The temperature of the mass in the centre was greater than near the surface. It was urged that the coals did not fire

when they were landed, and that therefore they might safely have been conveyed to their destination; but it was argued that by unloading, and by being spread out, they had been so cooled as to prevent the accident that would otherwise have occurred. (Page 155.)

5. **Taylor's Med. Juris., I., p. 713.**—(Destruction of the merchant ship "Earl of Eldon," 1834.)—Damp raw cotton was packed in the vessel. A month after leaving port, vapors were given off in large quantity, the evil being intensified by disturbing the bales, whereby a free current of air was created. Ultimately the ship caught fire, and both vessel and freight were entirely destroyed. (Page 162.)

6. **Taylor's Med. Juris., I., p. 714.**—A ship and its cargo destroyed by the spontaneous ignition of bales of cotton upon which oil had been spilt. (For other cases see "Ann. d'Hyg.," 1841, I., 367.) (Page 163.)

7. **Ann. d'Hyg., 1842, I., 211.**—Fire due to the spontaneous firing of cotton waste saturated with oil. A man accused of incendiarism was acquitted. (Pages 154, 163.)

8. **Knowles v. North British Insurance Company.**—(Manchester Assizes, 1865.)—The plaintiff claimed £300 fire insurance. Certain cotton waste had caught fire spontaneously, and to this the conflagration was due. The policy stipulated, however, that there should be no "oily or greasy waste" in the stock. The defendants pleaded a breach of this stipulation. The plaintiff urged that cotton was naturally oily. Verdict for the defendants. (Page 163.)

9. **Taylor's Med. Juris., I., p. 714.**—Reference made to the spontaneous ignition of a mixture of sawdust and oil. (Page 164.)

10. **Ann. d'Hyg., 1841, I., 384.**—In 1781 a fire occurred in a Russian frigate from the spontaneous ignition of sailcloth, which had come into contact with a mixture of boiled oil and lampblack, prepared for painting the vessel. It was found that this mixture, spread on cloth, fired in twenty hours when exposed to the air. (Pages 156, 164.)

11. **Koebel v. Saunders** (*C. P.*, 1865.)—The plaintiff sued the defendant on a policy of insurance on a cargo of cocoanut oil which had been stored with cocoanuts. The question here was leakage of oil, dependent on the shrinking of the staves of the cask from the heat developed by the fermentation of the cocoanuts, due to their having been wetted with sea water owing to bad weather. Verdict for plaintiff. (Page 164.)

12. **Taylor's Med. Juris., I., p. 716.**—The case of a ship set on fire by the spontaneous ignition of jute impregnated with castor-oil. (Page 164.)

13. **Records of Science, 1835.**—("Taylor's Med. Juris.," I., p. 716.) —The spontaneous combustion of "chipcake" (that is the chips of wood, leaves, and leaf-stalks as contained in the imported raw American turpentine). The mass caught fire about nine hours after it had been heaped. (Page 164.)

14. **Taylor's Med. Juris., I., p. 716.**—Destruction of the ship "Jane" (Aug., 1851), owing to the spontaneous ignition of a cargo of resin, turpentine, and tar. (Page 164.)

15. **Hepburn v. Lordan.**—(*V. C. Wood*, January, 1865.)—The plaintiff, a large leather dealer, brought an action against the defendant on account of the injury he believed would result from the spontaneous ignition of a mass of about 300 tons of a vegetable fibre (jute) stored in a yard adjoining his premises. The jute was damp, but it was not stacked in a confined space. The plaintiff argued the possibility of such an accident happening by reference to the analogous case of cotton. The defendants brought a mass of evidence to show that, although it might become heated, it merely dried, and that no case of the spontaneous ignition of jute had ever been heard of. Dried jute, it was admitted on all sides, was not spontaneously combustible. An injunction was, however, granted, on the ground of the danger of external ignition. (Pages 154, 162.)

16. **Taylor's Med. Juris., I., p. 720.**—Reference made to a suspected case of spontaneous firing in the Tyne Docks (1871) of damp esparto grass (?). (Page 162.)

17. **Ann. d'Hyg., 1841, I., 309.**—A barn loaded with oats was destroyed by fire. It was supposed to be the act of an incendiary. MM. Chevalier, Ollivier, and Devergie decided that it caught fire spontaneously, from the heat developed by fermentation, the result of damp storage. (Page 162.)

18. **Taylor's Med. Juris., I., p. 722.**—A fire occurred in a vessel laden with wool. It was believed to be spontaneous. (Page 163.)

19. **Chemical News, 1870, II., 145.**—(*M. Persoz.*)—A fire which occurred at a silk mercer's in Paris, was believed to be due to the stacking of very large quantities of dry black-dyed silk. (Page 163.)

20. **Proc. of R. S., Vol. XXVIII., p. 412.**—Details of colliery ex-

plosions at Pemberton, Oct. 11, 1877; at Blantyre, Oct. 2, 1877; at Unity Brook, March 12, 1878; at Apedale, March 27, 1878; at Haydock, June 7, 1878; at Abercarne, Sept. 11, 1878; at Dinas, Jan. 13, 1879. **Proc. of R. S., Vol. XXIV.**—Explosion at New Tredegar Colliery; also at Swaithe and Llan Collieries. **Proc. of R. S., June, 1881.**—Explosions at Risca, Seaham, and Penycraig. **British Med. Journal, July 24, 1880, p. 146.**—Account of the accidents arising from the Risca Colliery explosion. (Page 172.)

21. **British Med. Journ., March 5, 1870.**—Explosion of 2 cwt. of dynamite at a factory at Dunnwald, near Cologne. (Page 159.)

22. **Medical Times and Gazette, Aug. 19, 1871.**—Explosion of 15 tons of gun-cotton at Stowmarket. (Page 158.)

23. **British Med. Journal, Dec. 19, 1874.**—Male, æt. 32. Explosion of gas in a room. The person injured died from meningitis. (Page 173.)

24. **R. v. William Leonard, John O'Brien, and another.**—(*C. C. C.*, July 9, 1845. *Vide* "Times," July 11, 1845.)—The indictment charged the prisoners with having caused the escape of a certain quantity of inflammable gas, etc., etc. They were found not guilty, because of the invalidity of the charge, there being no law to embrace such a crime as that they had committed, gas being neither a corrosive fluid nor destructive matter. Further it could not be said that they had cast it over her. (Page 172.)

25. **Pharmaceutical Journal (3), VI., pp. 97, 113.**—Account of the explosion of a mixture of air and petroleum vapor on board the "Maria Lee" (June, 1873). The weather at the time was hot. The leakage of the petroleum took place in the hold of the vessel. (Page 168.)

26. **Pierre Aim Lair**, from "Coxe's Emporium of Arts and Sciences," Vol. I., p. 167, quoted by Beck. The wife of the Sieur Millet, of Rheims, was drunk every day of her life. The domestic economy of the house was managed by a handsome young female. On the 20th February, 1725, the wife was found consumed at a distance of a foot and a half from the kitchen hearth. A part of the head, a few of the vertebræ, and a portion of the lower extremities were all that remained unconsumed. A foot and a half of the flooring under the body was burnt, but a wooden kneading trough and a tub very near the body had sustained no injury. M. Chretien, a surgeon, examined the remains of the body with great precision. Jean Millet, the husband, being interrogated by the judges, declared that about eight P.M. on the 19th of February, he had retired to rest with his wife,

who not being able to sleep, had gone into the kitchen, where he thought she was warming herself. Having fallen asleep, he was roused by an infectious odor, and having run to the kitchen he found the remains of his wife in the state described by the medical reports. The judges formed an opinion that he had conspired with his servant to destroy the wife, and he was condemned to death. On appeal, however, to a higher court, this decree was reversed, and it was pronounced a case of spontaneous combustion.

Here it will be seen there were grave elements of suspicion, but even admitting the husband's statement, there is yet great improbability that the combustion was spontaneous, as the wretched woman was so close to the fire. (Pages 154, 165.)

27. Bianchini, quoted by Beck. (See also Lair, and the "Philosoph. Trans.," Vol. XLIII., p. 447. "Transactions of the Copenhagen Society.") —(1.) In 1692 a woman of the lower class who had taken little but intoxicating liquors for three years, sat down one evening in a straw chair to sleep. Next morning no part of her was found except the skull and the extreme joints of her fingers, all the rest of her body having been reduced to ashes.

(2.) The Countess Cornelia Bandi, of Cesena, in Italy, aged 62, was accustomed to bathe her body with camphorated spirits of wine. When her servant came to her one morning, she found nothing but the remains of her mistress's body in the most horrible condition. Four feet from the bed was a heap of ashes, in which the legs and arms alone were untouched. Between the legs lay the head; the brain, together with half the posterior part of the skull and the whole chin, had been consumed. Three fingers were found in the state of a coal, and the rest of the body was reduced to ashes, which, when touched, left on the fingers a fat, fetid moisture. A small lamp on the floor was covered with ashes, and contained no oil; the tallow of two candles was melted on a table, but the wicks still remained. The state of the bedding suggested that she had got out of bed. The bed itself was not damaged, though the furniture and tapestry were covered with a moist kind of soot, which had penetrated into the drawers and dirtied the linen. (Page 165.)

28.—(1.) On the 6th of January, 1847, a man, æt. 71, was found by his grandson lying in bed in a state of combustion. The chamber was filled with dense smoke, and one witness asserted that he saw a small whitish flame playing around the body of the deceased, which receded as the witness approached. The clothes and bedcoverings were almost entirely consumed, but not the wooden bedstead. Very little of the body was left. The man usually carried lucifer matches in his waistcoat-pocket, and a hot brick was placed at his feet when he went to bed. The son

and his wife were suspected of having murdered him, and Dr. Masson was commissioned to examine the exhumed body, but both he and Orfila are said to have agreed that it was a case of spontaneous combustion! ("Gazette Médicale," Sept. 4, 1847, and Taylor, *loc. cit.*, pp. 702–3.)

(2.) The same theory found favor in the case of the Countess of Goerlitz, for whose murder John Stauff was tried at Darmstadt, in March and April, 1850. This case is fully reported by Dr. Taylor. The subsequent confession of the murderer absolves us from quoting it at length.

(3.) One of the most recent cases of spontaneous combustion is that of a woman much given to drinking absinthe and other spirits. "On the 1st of August, 1869, having drunk largely, she went to her bedroom about 5 P.M. Two hours after, her husband trying to enter, found the door very hot. He raised an alarm of fire, and the room was entered by the window. There was a nauseous odor, and a sense of suffocation on entering. The dead body of the woman was found on the floor, between the bed and the hearth—the head being partly under the bed, and the legs across the hearth. There was no fire in the grate, and the trap was down. The floor on which the body lay was more carbonized than burnt; on it were found fragments of bones, some of the ribs, a hand, and some ashes. The head, which was swollen and livid (violet-red) presented no mark of burning. The hair, even, was not burnt, any more than the upper part of the trunk, which was covered with a black powder from the burnt clothes. The left arm was wanting from the shoulder. The right arm had lost its hand, which was disarticulated at the wrist. The elbow joint was exposed, but the muscles of the arms were not destroyed. The left side and front of the chest were widely open, but there was no trace of the viscera of the thorax. The lower ribs were separated. The walls of the abdomen were gone, and its cavity empty, the viscera being reduced to a greasy black soot, adhering to the vertebræ. The bones of the spine and pelvis remained, but the muscles and faciæ had disappeared. The lower limbs, from the thighs downward, were entire, the skin being covered with a black powder, but there were no blisters on these parts. It was further stated that although there was no apparent source of fire or of ignition in the room, and that the bed and its furniture had escaped burning, nevertheless that the floor was still on fire [smouldering] when the room was entered. Neither candle, match, nor fuel were found near the body. No noise or cry of alarm was heard, and the opposite neighbors saw no signs of fire to attract their attention to the chamber.

[See reports of Drs. Bertholle and Strohl in "L'Union Médicale," November 19, 1870, and the "Ann. d'Hygiène," 1871, I., 228; and Taylor, *loc. cit.*, p. 705. Dr. Taylor suggests that the wretched woman in all probability had matches about her person. As regards the dark greasy or sooty matter, and the empyreumatic odor, he refers to Tardieu's paper in the "Annales d'Hygiène," 1850, II., 191 and 363, and for 1851, I., 99;

and also to a paper by Dr. Ogston in the "Medical Gazette," Vol. XLVI., pp. 889 and 948.]

(4.) Dr. Taylor records a curious case in which a dead body was found thirteen months after death almost entirely consumed along with the coffin. It appears that a bad smell attracted attention to the vault, which was opened; the coffins (one of which was of metal) had burst, and the body therefore was placed with sawdust in the coffin, the gas turned off, and all, as was thought, left safe. But in the morning the vault was found on fire, with the result above mentioned (Taylor, *loc. cit.*, p. 706). Mr. Worthington, of Garston, near Liverpool, who consulted Dr. Taylor on the case, discovered that one of the workmen was smoking in the vault the night before, and as there were gaspipes, the cause of the accident is not far to seek. No doubt the sawdust acted as fuel. (Page 165.)

29.—In the "Philosoph. Trans.," Vol. XLIII., p. 463, it is recorded that "Grace Pett, the wife of a fishmonger, of St. Clement's, Ipswich, used to go downstairs every night half dressed to smoke a pipe. On the 9th of April, 1744, she got up from bed as usual. Her daughter, who slept with her, did not perceive that her mother was absent till next morning when she awoke. Soon after this she put on her clothes, and going down into the kitchen found her mother stretched out on her right side, with her head near the grate. The body was extended on the hearth, with the legs on the deal floor, and it had the appearance of a log of wood consumed by a fire without apparent flame. On beholding the spectacle, the girl ran in great haste and poured some water over her mother's body, to extinguish the fire. The fetid odor and smoke which exhaled from the body, almost suffocated some of the neighbors who had hastened to the girl's assistance. The trunk was in some measure incinerated, and resembled a heap of coals covered with white ashes. The head, arms, legs, and thighs had also participated in the burning. This woman, it was said, had drunk a large quantity of spirituous liquor, in consequence of being overjoyed at hearing that one of her daughters had returned from Gibraltar. There was no fire in the grate, and the candle had burnt entirely out in the socket of the candlestick, which was close to her. There was also found near the consumed body the clothes of a child, and a paper screen, which had sustained no injury. Her dress consisted of a cotton gown. (Page 165.)

30.—Another of Le Cat's cases quoted by Beck was given him by M. Boinneau, curé of Plurguer, near Dol. It occurred in 1749. Madame de Boiseon, aged 80, a great spirit-drinker for many years, was sitting in her elbow-chair before the fire, while her waiting-maid went out of the room for a few moments. The maid on her return, seeing her mistress on fire, immediately gave an alarm, and some persons having come to her aid, one of them tried to extinguish the flames with his hand, but they adhered to

it, as if it had been dipped in brandy or oil. Water was brought and thrown over her, yet the fire appeared more violent, and was not extinguished till the whole flesh had been consumed. Her skeleton, exceedingly black, remained entire in the chair, which was only a little scorched. One leg only and the two hands detached themselves from the rest of the bones. It is not known whether her clothes had caught fire by approaching the grate ; but she was in the same place in which she sat every day. There was no extraordinary fire at the time, and she had not fallen from the chair. (Page 165.)

31.—(1.) Dr. Taylor (*loc. cit.*, p. 701) relates the case of a woman addicted to habits of intoxication, who was found dead in her room in December, 1864. Her clothes were on fire, and a chair had been burnt. The room when entered was filled with a thick, black, offensive smoke. On examination some of the bones were found quite bare of flesh. A candle was still burning on the table, and there was also a fire in the room. But for this the case (as Dr. Taylor says) might have been taken for one of spontaneous combustion.

(2.) He also mentions the case of Mrs. Pulley, whose body was examined by the late Mr. Jackson, of Stamford, in 1860. The circumstances required little ingenuity to transform them into a case of spontaneous combustion, instead of, as it really was, an attempt to conceal murder by strangulation. There had been no fire in the grate. The deceased was lying on the hearth of her room, three or four feet from the grate. From the shoulders downward the body lay on a boarded floor of oak. She was fully dressed, and parts of her clothing and body had been destroyed by fire. A brass candlestick was lying between the left arm and the body, the top of the candlestick being inclined toward it. Her clothes were wholly burnt off both arms, and partly off the upper portion of the trunk. The legs were not at all burnt. A bonnet worn by her was partly burnt. The right arm was raised by the side, with the elbow resting on the floor. The fingers were partly burnt off, and the remainder of the hand was charred. Her left hand (which was stretched out) was less burnt than the right. Some ashes from the clothing lay between the left arm and the body. The fire was extinguished when the room was entered, but there was a strong smell of burning. Under the body was a hole burnt in the oak floor. Her features were distorted and swollen, and the eyes suffused with blood. Some parts were burnt to a cinder, whilst others were but little affected by the fire. (Page 165.)

32.—In the case of **R. v. Hatto** (Aylesbury Lent Assizes, 1854), in which Dr. Taylor was consulted, a woman was found dead in her room, much burnt. She was known to have been alive about 8.15 P.M., whilst her body was found still smouldering at 11.15 P.M. Her clothes were much

burnt. The most important point in this case, as it appears to us, is that Dr. Taylor found that a hempen mat under the body was so saturated with melted human fat, that it burned like a link when he ignited it. The subsequent confession of the prisoner showed that the burning of the body must have taken place in less than two hours, and possibly in about an hour and a half. "Both knees," said the surgeon, "were consumed by fire, and the thighs, as well as the private parts, were burnt to a cinder, leaving the shafts of the thigh bones exposed and charred for several inches. Between the thighs and the feet the floor underneath had been burnt away, and the leg bones had fallen through the floor, leaving the feet, unburnt, upon the floor." Her clothes were much burnt. (Page 165.)

33.—(1.) The case of the priest Bertholi, in 1776, in Italy, quoted by Foderé, Vol. III., p. 210; "London Medical Repository," Vol. I., p. 332; and given by Beck in foot-notes, is also extremely curious. "He had retired to a room in his brother-in-law's house, as was supposed, to pray. In a few minutes his cries caused the room to be entered. He was found extended on the floor, and surrounded by a light flame, which receded as they approached, and finally vanished. The next morning M. Battaglia was called, and examined the patient. He found the integuments of the right arm almost entirely detached from the flesh; also between the shoulders and thighs the integuments were injured. There was mortification of the right hand, which in spite of scarification rapidly extended. The patient complained of burning thirst, and was horribly convulsed; he passed by stool putrid, bilious matter, and was exhausted with the continual vomiting, accompanied by fever and delirium. On the fourth day, after two hours' insensibility, he expired. A short time previous to his death M. Battaglia observed with astonishment that the body exhaled a most insufferable odor—worms crawled from it on the bed, and the nails had become detached from the left hand. The account of the patient was that he felt a stroke like the blow of a cudgel on the right hand, and at the same time saw a bluish flame attack his shirt, which was immediately reduced to ashes, the wristbands remaining totally untouched. A handkerchief between the shoulders and shirt was entire, and free from any trace of burning. His breeches were also uninjured, but though not a hair of his head was burnt, yet his cap was entirely consumed. There had been no fire in the room, but the lamp, which had been full of oil, was now dry, and its wick reduced to a cinder." The vagaries of this fire are more like the effects of lightning than anything else.

(2.) A case, said to have occurred in the neighborhood of Bordeaux in September, 1822, is too absurd to require either quotation or refutation. The curious may find it in a foot-note to page 528 of Beck's work, where a number of references to articles on the subject and to other recorded cases will be found. (Page 165.)

CHAPTER VI.

STARVATION.

Circumstances under which Death from Starvation may Occur.—Varieties of Food.—Relative Values of Foods.—The Quantity of Food necessary to Support Life at Different Ages.—The Symptoms of Starvation.—Treatment.—Post-Mortem Appearances.—Diseases arising from a Deficient Diet, or from an Improper Quality of Food.

(ILLUSTRATIVE CASES, PAGE 219.)

BY *acute starvation* is implied the deprivation of all food from a person previously well fed. By *chronic starvation* is implied the withholding of food either sufficient in quantity, or proper in quality, to support life.

The following cases bearing on starvation may present themselves to the medical jurist:—

1. A mother may be charged with causing the death of her infant, by preventing it from taking the breast. (*Case* 42.)

2. Parents or employers may be charged with giving their children, apprentices, or servants insufficient nourishment, and so causing either their death or a danger of death. (*Cases* 42 to 47*.)

3. Real or pretended cases of prolonged fasting, or the conduct of persons concerned in such cases, may be called in question, and submitted to the medical jurist. (*Cases* 1 to 7, etc.) (See a paper by Dr. L. S. Winslow, in the "*Journal of Psych. Med. and Mental Pathology*," Nov., 1880.)

In an indictment for murder or manslaughter by starvation, the defence set up is invariably, that admitting starvation to be the cause of death, it was the result of disease, and not an act of wilful malice on the part of the prisoner. (Vide *R.* v. *Pryke*, Chelmsford Summer Assizes, 1840; *R.* v. *Mitchell*, Oxford Lent Assizes, 1861.) Hence to support a charge of starvation, the absence of organic disease should, if possible, be proved, although it must be remembered that the presence of organic disease does not disprove that death may have resulted from criminal starvation.

We may here inquire in somewhat greater detail respecting the circumstances under which death may occur from starvation, and so become a subject of legal inquiry.

I. *Disease.*—Thus in cases of mal-assimilation of food (*Cases* 12, 47*), of chronic diarrhœa (*Case* 47*), of cancer of the stomach (*Case* 15*), of œsophageal stricture (*Case* 15), in certain forms of paralysis (*Case* 14), and perhaps more frequently than all, in cases of closure of the pancreatic duct, death may result from true starvation, the effect of organic disease.

Again, chronic starvation may result from the nausea of pregnancy. This may become so uncontrollable as to terminate fatally.

Again in children, where the mother's milk or the cow's milk employed is wanting in fat, we may have the functions of the pancreas, after they have been developed, paralyzed by prolonged inactivity, or in the case of very young infants the organ may remain inactive because not called to the full performance of its duties at a proper age. (Dobell, "On Loss of Weight," p. 268. "*Med. Times and Gazette,*" June, 1868 (Dr. Brakenridge).) This fact is of importance in days when pure milk (owing to Adulteration Acts) is more difficult to obtain than it ever was, and when preparations of preserved milk, from which the fatty constituents have been removed and a superabundance of saccharine matter added, are so largely used for the food of children, contrary to all sound principles of infant diet. That a child may, under such circumstances, plump though it appear, grow up to be a miserable dyspeptic, and die of physiological starvation, must not be lost sight of.

A dislike to, and abstinence from food, proving serious in its results, is not uncommon in young girls at or about their first menstrual period. ("*Med. Times and Gazette,*" Jan. 22, 1870.) Connected, as this dislike to food most often is, with hysteria, it should be met peremptorily and with a strong will. (*Case* 10.) Hysterical insanity, the general cause of an occasional epidemic of "fasting girls," is a disease that requires treatment, and the sufferers, like people out of their mind, need to be taken care of. ("*British Medical Journal,*" 1878, I., p. 254.) Commencing with a genuine dislike to food, the patients stand a chance of being seized upon by idle parents as excellent money-making exhibitions, and either prevented from taking nourishment when the desire returns, or all forms of deception (such as night-feeding, etc.) practised, to keep up the outside interest, lest the profitable business be interfered with. (*Cases* 1, 2, 5, 6, 9.)

But this subject has another aspect besides that of the showman

and the marvel-monger. Chronic starvation may occur in young girls, who in consequence of home neglect, or the want of a sufficiently good diet at school, or the neglect of treatment when anæmic, fall into a condition of extreme weakness and debility, just as the menstrual function is beginning to establish itself. The systematic rejection of food by the patient (a matter possibly of no great concern to the economical school-mistress) retards menstruation, and so increases the trouble. It is certain that girls at such a time require more than a *little* meat and bread-and-butter pudding once a day, more especially when perhaps they are expected (healthy and feeble alike) to take a long daily walk. Girls of 16 or 17 require at least two good meat meals a day, to meet the drain the system is called upon to bear at this time of life, and on the proper treatment of which their future health so much depends.

Cases 6 and 8 are illustrations of how abstinence from food is often associated with uterine irregularities and disturbances.

Acute melancholia (*Case* 12) and *idiocy* (*Case* 12*) may be causes of starvation, and must be met by prompt and careful treatment.

II. *Criminal Neglect.*—Such cases may occur in young children, or in aged persons dependent on others for food. By 31 and 32 Vic., c. 122, s. 37, it is "a misdemeanor to refuse or neglect to provide sufficient food or other necessaries for any infant of tender years, unable to provide for and take care of itself (whether such infant be child, apprentice, or servant), whom the party is obliged by duty or contract to provide for, so as thereby to injure its health." (See "Russell on Crimes," I., 499, where the cases are collected.)

In the case of a mother being charged with not suckling her infant, it may be urged that either she lost her milk, or that from insufficient food owing to poverty, her milk became so poor that it failed to afford proper nourishment to the child. The possibility of such conditions must be admitted. ("*Medical Times and Gazette*," 1871, II., 656.) More than this, it is within our own experience, that some human milk (although the mother may be well fed) is so absolutely wanting in nutritive properties, that a child may die of starvation although it seems to be sucking ravenously at well-filled breasts. (Page 191.)

III. Starvation may be suicidal. (*Cases* 30, 32, 35, and 40.) Such attempts are usually the acts of prisoners who refuse food, either to make themselves ill, or to feign insanity declaring that they fear poison, or from a feeling of resentment. Few, however, have the courage to carry out for very long their determinations. Thus in *Case* 37 the

resolution to commit suicide by starvation failed on the ninth day, in *Case* 31 on the tenth day, and in *Case* 36 on the eleventh day.

IV. Lastly, an exhibition of starvation for forty days and nights as a money-making concern (probably not unprofitable) occurred in the case of the notorious Dr. Tanner. (*Case* 48.) (See *B. M. J.*, 1880, II., pp. 171 and 215.) During his fast he took plenty of water, which no doubt materially assisted the kidneys in purifying the blood. Dr. Tanner's fast, further, occurred in hot weather (July and August) :— hence the normal temperature was somewhat easily maintained. We confess, however, that the remarkable return of appetite raises some doubt as to the genuineness of the exhibition.

There are one or two points of legal interest bearing on the question of starvation to which we may refer here :—

(1.) If a man supplies his wife with sufficient money to buy food for their children, which she neglects to do, either squandering the money on drink, or hoarding it, or not devoting it to the object for which it was given her, the man is held blameless but the woman is culpable. On the other hand, if it is proved that sufficient money was not supplied the woman by her husband, the man only is culpable. This is founded on the principle that the wife in law is the husband's servant. (*R.* v. *Edwards*, 8 C. & P., 611, *per* Patteson, J.)

Several decisions of the judges (*e.g.*, *R.* v. *Downes*, 45, L. J., M. C., 8) in trials of the "Peculiar People," etc., have shown that medical attendance and medicines are considered necessaries, and that a husband is bound to provide them for his wife, and a parent for his or her child, etc. On the other hand, the decision in the recent case of *R.* v. *Morby* (*Case* 50) has laid it down that, to support an indictment of manslaughter for not providing medical attendance to a child, it must be shown that the neglect caused or accelerated the child's death. A want of cleanliness in the case of lunatics, children, and sick persons, is very justly considered an aggravation of the neglect to provide sufficient food.

(2.) With regard to servants and apprentices, it has been held that the husband, and not the wife, is bound to provide food for them. (*R.* v. *Squire.*) But a wife may be, and sometimes is, charged as an accessory or accomplice in the crime.

(3.) With regard to unweaned *infants*, it has been held that the mother alone is criminally responsible if the death arise from her not suckling the child when she was capable of doing so. (*R.* v. *Davey*, Exeter Lent Assizes, 1835.) Nevertheless the father may be accessory to the death.

(4.) It has been held that parents are bound to supply the wants of their children of tender years. Thus, in cases of pretended fasting, where, for fear of detection, food is absolutely withheld from a child by its parents or guardians, they are guilty of manslaughter if the child dies, although the child itself be a consenting party. (Hannen, J., *R.* v. *Jacobs and Wife*, Carmarthen Summer Assizes, 1870, *Case* 1.)

(5.) The numerous cases of *baby-farming* within the past few years led to the passing of a special Act of Parliament. The cases of *R.* v. *Mary Hall* and *R.* v. *Margaret Waters* show how, in addition to improper food, farmed children are often criminally neglected, and drugged with preparations of opium to keep them quiet.

Before considering the subject of starvation in detail, there are certain points connected with food generally that it may be well in the first instance to discuss.

(*a.*) The Varieties of Food.

Variety of food is absolutely essential to health. The only food which by itself is capable of sustaining life, and building up tissues for an indefinite period, is *milk*. This is to be regarded, therefore, as the model diet—the perfect type of what food ought to be.

Its composition, in different mammals, varies somewhat :—

	Woman.	Cow.	Goat.	Sheep.	Ass.	Mare.
Water	890	860	868	856	907	888
Solids	110	140	132	144	93	112
	1000	1000	1000	1000	1000	1000
Butter	25	38	33	42	12	8
Casein	35	68	40	45	16	16
Sugar and extractives	48	30	53	50	65	88
Fixed salts	2	6	6	7		

If we analyze the constitution of milk, we find that dissolved or suspended in the water are certain oleaginous, nitrogenous, saccharine, and mineral constituents :—

(1.) *Water*, amounting to about 90 per cent. by weight. Experience shows that for adults two to three pints, and for infants one to

two pints of liquid, are required for health per day, in addition to the water ordinarily present in articles of food. When too little water is ingested, a great accumulation of used-up material takes place in the system, so that nutrition is interfered with, and a train of unpleasant symptoms developed. A deficiency of drink is said to cause nervous exhaustion. (See "*Boston Med. Journ.*," July 8, 1880. Dr. Webber.)

(2.) The quantity of fatty or *oleaginous* matter (butter), is greater in cow's than in woman's milk. Fatty food is absolutely necessary for the maintenance of animal heat, for the growth and repair of nerve tissue, and perhaps for other purposes. The inhabitants of cold countries appear to be able to assimilate more fat than those living in temperate or tropical regions. The author has been informed that a few years ago a troublesome outbreak of skin disease (somewhat allied to eczema, but of dartrous nature), occurred amongst the pauper children in the Haverfordwest workhouse, which quickly yielded when a more liberal allowance of butter was permitted. If butter, on account of cost, is suppressed, or sparingly given, dripping, or some other kind of animal fat, ought to be substituted.

From a practical point of view, the sale of fatty material, be it "butterine" or any other oleaginous body, so long as it is wholesome, should be assisted, and not checked by needless prosecutions. As a question of *taste*, butter is no doubt preferable to butterine, but as a question of *food* and *nourishment*, the one is as good as the other.

(3.) The casein of milk is the representative of the *nitrogenous* constituents of food. The gluten of bread—the legumin of pease, beans, and other legumes—the albumen of eggs—the myosin of muscle—the gelatin of bones, ligaments, tendons, etc., are similar in their general constitution.

Although health cannot long be maintained on pure albumen, yet albuminous foods are necessary for the repair of muscular waste.

(4.) Again, in milk we have *saccharine* and *extractive* matters. These answer to the saccharine and starchy constituents of bread and other vegetable foods (Amylaceous). And here it may be remarked that the term *farinaceous* is not equivalent to *amylaceous*. Farinaceous food contains gluten, legumin, or some other form of vegetable albumen, and the name signifies that it resembles farina or flour. Arrowroot, sago, and tapioca are amylaceous or starch foods; whilst the flour of wheat, Indian corn (maize), barley, oats, lentils, beans, peas, etc., are farinaceous or farina foods.

(5.) Lastly, we have *mineral* constituents in milk. The chlorides, phosphates, and carbonates of the alkaline and earthy metals, and the salts of iron and perhaps of manganese, are the most important of

these. Criminals were at one time deprived of salt in Holland, and are said to have perished miserably.

(β.) The Relative Values of Different Foods.

The following table from Dr. Letheby's work shows the *relative values* of different foods. In using such tables regard must be had to age, climate, and other circumstances of life, and also to the individual powers of digestion.

Nutritive Value of Foods.

[In this table carboniferous matter is calculated as starch, ten of fat being equal to twenty-four of starch.]

Substances. (100 parts.)	Water.	Fibrin, Albumen, etc.	Starch, Sugar, etc.	Fat.	Salts.	Carboniferous.	Nitrogenous.	Total Nutriment.
Human milk	89	3.5	4.2	3.0	0.2	11.4	3.5	14.9
Cow's milk	86	4.5	5.0	4.1	0.7	14.8	4.5	19.3
Skimmed milk	87	4.5	5.0	2.7	0.7	11.5	4.5	16.0
Butter milk	87	4.5	5.0	0.5	0.7	6.0	4.5	10.5
Beef and mutton	73	19.0	—	5.0	2.0	12.0	19.0	31.0
Veal	77	19.0	—	1.0	0.6	2.4	19.0	21.4
Poultry	74	21.0	—	3.0	1.2	7.2	21.0	28.2
Bacon (fat)	20	0.8	—	70.0	1.3	168.0	0.8	168.8
Cheese (Cheddar)	36	29.0	—	30.0	4.5	72.0	29.0	101.0
Cheese (skimmed)	44	45.0	—	6.0	5.0	14.4	45.0	69.4
Butter	15	—	—	83.0	2.0	199.0	—	199.0
Eggs	74	14.0	—	10.5	1.5	25.0	14.0	39.0
White of egg	78	20.0	—	—	1.6	—	20.0	20.0
Yelk of egg	52	16.0	—	30.0	1.3	72.0	16.0	88.0
White fish	79	19.0	—	1.0	1.2	2.4	19.0	21.4
Salmon	78	17.0	—	4.0	1.4	9.6	17.0	26.6
Eel	80	10.0	—	8.0	1.3	19.2	10.0	29.2
Wheat flour	15	11.0	70.0	2.0	1.7	74.8	11.0	85.8
Barley meal	15	10.0	70.0	2.4	2.0	75.8	10.0	85.8
Oat meal	15	12.0	62.0	6.0	3.0	76.4	12.0	88.4
Rye meal	15	9.0	66.0	2.0	1.8	70.8	9.0	79.8
Indian meal (maize)	14	9.0	65.0	8.0	1.7	84.2	9.0	93.2
Rice	14	7.0	76.0	0.3	0.3	76.7	7.0	83.7
Haricot	19	23.0	45.0	3.0	3.6	52.2	23.0	75.2
Peas	13	22.0	58.0	2.0	3.0	62.8	22.0	84.8
Beans	14	24.0	44.0	1.4	3.6	47.4	24.0	71.4
Lentils	14	29.0	44.0	1.5	2.3	47.6	29.0	76.6
Wheat bread	44	9.0	49.0	1.0	2.3	51.4	9.0	60.4
Rye bread	48	5.0	46.0	1.0	1.4	48.4	5.3	53.7
Potatoes	74	2.0	23.0	0.2	0.7	23.5	2.0	25.5
Green vegetables	86	2.0	4.0	0.5	0.7	5.0	2.0	7.0
Arrowroot	18	—	82.0	—	—	82.0	—	82.0

(γ.) The Quantity of Food required to Support Life at Different Ages.

This question is best approached from purely physiological considerations. An average adult loses daily about 4,500 to 4,600 grains of carbon, and 300 of nitrogen, or very nearly 11 ounces of solids, by some such means as the following:

Loss by the lungs			about	32.0	per cent.	of the	entire loss.
"	"	skin	"	17.0	"	"	"
"	"	fæces	"	4.5	"	"	"
"	"	urine	"	46.5	"	"	"

Now it is important to note that if a man were to live on albuminous articles of food only (the ratio of carbon to nitrogen in these being about 3.5 to 1) he would be taking about fifteen times as much nitrogen as he requires, in order to get sufficient carbon. Hence other articles of food, such as the amylaceous or starchy varieties, become a necessity.

Again, as the proportion of carbon to nitrogen in bread is about 30 to 1, it follows that if a man ate enough bread to give him all the nitrogen he requires, he must take about twice as much carbon as he really wants.

To put this matter in a practical form, let us suppose a man to live entirely on butcher's meat: he would require nearly 6½ pounds (or 45,000 grains) daily, in order to obtain sufficient carbon for his daily needs, in consuming which he would take about 1,500 grains more nitrogen than is necessary. Thus:

Carbon	4,500	grains in 6½ lbs. of meat.
Nitrogen	1,830	" " " "

Excess of Nitrogen above that required = 1,500 grains.

Or again, let us suppose that he attempted to live on bread alone: he would then require about 4¼ lbs. (30,000 grains) daily in order to obtain sufficient nitrogen, in which case he would consume double the quantity of carbon required. Thus:

Carbon	9,000	grains in 4¼ lbs. of bread.
Nitrogen	300	" " " "

Excess of Carbon above that required = 4,500 grains.

It is evident, however, that a combination of bread and meat would more economically supply his wants. Thus:

	Carbon. Grs.	Nitrogen. Grs.
15,000 grains of bread (or rather more than two pounds) contain	4,500	150
5,000 grains of meat (or about ¾ pound) contain	500	150
	5,000	300

The next question we must consider is the practical one:—

How much Food should a healthy Adult and a healthy Infant Consume Daily?

Stated broadly it may be said that for a man of about nine or ten stone (126 to 140 pounds), two pounds of bread, three-quarters of a pound of meat, and from one and a half to three pints of fluid per day is sufficient. Authors, however, differ somewhat in their estimates. Thus Dr. Dalton ("*Physiology*," 1871, p. 101) states that rather less than two and a half pounds of solid and rather over three pints of liquid food, are required by a man in full health, taking free exercise. This he apportions as follows:—

Meat	16 oz. or 1.00 lb. avoirdupois.
Bread	19 oz. or 1.19 " "
Butter or fat	3½ oz. or 0.22 " "
Water	52 fluid oz. or 3.38 " "

Vierordt ("*Grundriss der Phys.*," 1860, p. 192) considers an adult to be well nourished, if with moderate exercise he takes daily about 4 ounces of dry albumen, 3 ounces of fat, 11½ ounces of some starchy substance, and about 1 ounce of salt. This gives a proportion equal to 1 part of nitrogenous to 3.5 parts of non-nitrogenous food. If to this be added about 6 pints of water and the oxygen taken up in the act of respiration (which he estimates at 1.5 pound), we obtain a total of about one-twentieth of the body weight consumed in twenty-four hours. But this quantity of food is, we consider, insufficient, at least for active exercise.

In the Navy, the men get 31 to 35½ ounces of *dry* nutritious material daily. Of this 26 ounces is vegetable and the rest animal, and, like the diet of the British soldier, contains 5 ounces of nitrogen and 10 ounces of carbon compounds.

Dr. Edward Smith gives the following diet-scale for a man in good health, with good appetite and moderate exercise:—

Breakfast: ¾ pint of milk, ¼ pint of water with tea or coffee; bread, 4 to 6 ounces; butter, ¾ ounce; sugar, ¾ ounce; bacon, 3 ounces, or eggs, 4 ounces [2 to 3 eggs], or cooked meat, 3 ounces. *Dinner:* Cooked meat, 4 to 6 ounces; potatoes, 8 ounces; bread, 3 ounces to 4 ounces; pudding, 8 ounces; cheese, ½ ounce; soup, 6 ounces; water or beer, ½ pint. *Tea:* Water with tea, ¾ pint; sugar, ¾ ounce; milk or cream, 2 ounces; bread, 3 ounces; butter, ½ ounce to ¾ ounce. *Supper:* Milk, ¾ pint; oatmeal, 1 ounce; bread, 3 to 4 ounces; or eggs, 4 ounces, or cooked meat, 3 ounces, and bread, 3 ounces; butter or cheese, ½ ounce; water or beer, ½ pint.

The following table from Dr. Letheby's work on food gives some further dietaries.

Dietaries and their Nutritive Values.

Diets.	Weekly Consumption (in Ounces).							Daily Ditto.		
	Bread or Biscuit.	Meat.	Potatoes.	Meal, etc.	Milk.	Cheese.	Butter.	Carboniferous.	Nitrogenous.	Total solid Nutriment.
Physiological	140	84	—	—	—	—	3.5	12.7	4.0	16.7
Prison Punishment	112	Will only sustain life for a limited period, when combined with water.						8.2	1.4	9.6
English County and Borough Gaols:										
Under 7 days	121	—	—	23	39.5	—	—	12.4	2.2	14.6
Not hard labor	172	7.8	3.2	22.8	15.4	3.5	—	15.7	3.1	18.8
Hard labor	163	14.6	63.4	27.2	41.6	1.5	—	18.2	3.5	21.7
Scotch Prisons:										
Under 3 days	112	—	—	—	—	—	—	11.2	1.9	13.1
Not hard labor	30	7.5	152	73	175	—	—	19.0	3.4	22.4
Hard labor	76	10	176	100	175	—	—	27.0	4.5	31.5
Irish Prisons:										
Under 1 month	56	—	192	70	70	—	—	19.5	2.9	22.4
Not hard labor	56	—	192	60	170	—	—	20.5	3.4	23.9
Hard labor	64	—	219	70.5	170	—	—	22.0	3.6	25.6
Military Prisons:										
Under 84 days	56	—	—	119	210	—	—	22.2	3.8	26.0
Over 84 days	56	—	—	168	210	—	—	27.8	4.7	32.5
Convict Prisons	161	36	112	12	12.8	—	—	18.4	3.6	22.0
Union (adults)	112	15.5	51	17	34	5.2	1.1	14.2	2.8	17.0
Union (children)	90	14	32	—	105	—	3.5	11.1	2.3	13.4
Lunatic Asylums	114	23	68	16	14	7	1.3	13.2	4.0	17.2
Public Hospitals	93	52	56	14	7	—	3.2	12.1	3.5	15.6
Army (Crimea)	112†	112	—	—	—	—	—	14.5	4.8	19.3
Army (Home)	168	84	112	—	—	—	—	19.4	4.8	24.2
Army (in Madras)	112	112	56	4*	—	—	—	16.5	4.9	21.4
Navy	112†	112	56	—	—	—	—	17.7	5.0	22.7
Navvy (in the Crimea)	140†	140	—	28	—	—	—	17.8	6.2	24.0
Navvy or Navigator (Home)	320†	96	64	—	—	12	4.0	18.6	7.7	26.3
Yorkshire laborer	280	126	28	—	210	—	49	42.2	8.8	51.0
Berwickshire laborer	122	—	—	224	224	—	—	37.1	7.0	44.1

Note.—In this table only the most important articles of diet are mentioned, although the remainder, excepting beer, spirits, tea, and coffee, are calculated in the daily consumption. *Moderate rations of rice, and † of biscuit. Gruel is calculated at the rate of two ounces of meal per pint.

Dr. Dobell has discussed at considerable length the essentials of a normal diet for adults and children (the latter being contributed to his work by Dr. Sansom), and to these carefully considered statements of practical physicians the reader is referred for further details. (Dobell's "*Diet and Regimen*," pp. 62–82.)

In practice it is found that some people take rather more, and others rather less than the amount stated. This depends more on habits of life and constitution, than on mere body weight. Thus growing children and young adults, those who lead an active life in the open air, pregnant women, etc., require more food than older persons, or those of sedentary habits.

It is difficult to place a limit to the rapacity of gluttons, and of lunatics with inordinate appetites! Captain Parry's Esquimaux devoured no less than 35 pounds of various aliments, including tallow-candles, in twenty-four hours. A certain Hindoo is said to have eaten a whole sheep at one time. Sir John Franklin states that the half-breed *voyageurs* of Canada are very discontented when put on a short allowance of 8 pounds of meat a day, their usual consumption being from 12 to 20 pounds. The wandering Cossacks of Siberia, according to Captain Cochrane, are not much less hearty! But these exceptional peculiarities scarcely interest the medical jurist.

Although the principles laid down are undoubtedly true for the mass (and when dealing with the diet of a number, it is better to err on the safe side of plenty than on the dangerous one of deficiency), yet there are instances of health and longevity attained on a very restricted diet. Of these, the two best known are those of Cornaro, whose diet was only 12 ounces of solids (chiefly vegetable), with 14 ounces of light wine daily, on which he subsisted for fifty-eight years; and that of the miller of Billericay (Thomas Wood), who is said to have sustained a remarkable degree of vigor for upward of eighteen years upon 16 ounces of flour made into a pudding with water per day. No doubt life, and some strength may be long sustained on a comparatively meagre diet, if the supply of liquids is unrestricted. In some cases (as in the two mentioned) more liquid is said to have been excreted by the kidneys than was taken by the mouth. This is the probable key to that sudden increase of weight remarked at times in the case of jockeys and others, which would otherwise be inexplicable, except on the hypothesis of trickery. On this point, "there are certain phenomena," says Dr. Carpenter ("*Physiology*," pp. 168–9), "which, if accurately recorded, cannot be accounted for in any other way than by admitting that, under particular circumstances, a considerable amount of water may be absorbed from the vapor of the atmosphere.

Lining observed that his body on one occasion increased in weight, during two hours, to the amount of 8½ ounces, allowance being made for the amount of fluid ingested and for the quantity passed off by the urine, and by cutaneous transpiration during the time. Dr. Jurin affirms that he ascertained an increase of 18 ounces to have taken place during a night passed in a cool room after a day's exercise and abstinence. Dr. Watson states that a lad at Newmarket having been almost starved, in order that he might be reduced to a proper weight for riding a match, was weighed at 9 A.M. and again at 10 A.M., and he was found to have gained nearly 30 ounces in weight in the course of this hour, though he had drunk only half a glass of wine in the interim. A parallel instance was related to the author by the late Sir G. Hill, then Governor of St. Vincent:—A jockey had been for some time in training for a race, in which that gentleman was much interested, and had been reduced to the proper weight; on the morning of the trial, being much oppressed with thirst, he took one cup of tea, and shortly afterward his weight was found to have increased 6 pounds, so that he was incapacitated for riding." Should such a question in connection with racing matters become matter for medical evidence, one would expect to find (in addition to the evidence of credible witnesses), the two following conditions:—

1st. A previous course of privation, exercise, or sweating, so as to predispose to absorption.

2d. That the air at the time contained a considerable amount of watery vapor.

With respect to the amount of food required by children, we are informed that in a well-managed school, where the average numbers are over 400, including both boys and girls, the children averaging from nine to fourteen and presenting a picture of health, the daily diet consists of—

Bread........................	from 6 oz. to 16 oz., according to age.
Meat (cooked)................	from 4 " to 6 " " "
Butter or cheese..............	from ½ " to 1 " " "
Vegetables (chiefly potatoes)..	from 4 " to 8 " " "
Milk........................	15 fluid ounces.

This will give about 12¼ ounces of carbon and about 2¾ ounces of nitrogen compounds daily.

Infants are said to consume no less than 136 grains of carbon per

pound of body-weight, or from three to four times in proportion to weight, as much as an adult.

The quantity of nitrogen consumed by an infant per pound of body-weight, is about six times that of the adult. Similarly the adult excretes about 3 grains of urea (nearly one-half of which is nitrogen) per pound of body-weight, whilst the infant excretes about 5 grains per pound of body-weight. In other words, a man of 10 stone gets rid of about an ounce of urea, whilst an infant of 24 pounds gets rid of about $\frac{1}{4}$ of an ounce of urea per diem.

For an infant fed wholly upon milk (as all babies who have no teeth, or only one or two teeth, should be), we consider they require from 1 to 3 pints daily, according to age.

Physiologists are now agreed that starchy food alone is not a proper diet for infants.

The question may arise as to the quantity of milk secreted by women during lactation. Lamperriere obtained about 1 kilogramme of milk in twenty-four hours (equal to about 35 ounces):—*i.e.*, about 22 grammes to each kilogramme of body-weight. This agrees nearly with M. Guillot's estimate of 32 to 64 ounces, founded on the comparative weight of the infant before and after lactation. ("*L'Union Médicale*," 1852, No. 16.)

The question, "*How long is it since a meal has been taken?*" is not infrequently asked of the medical witness. Without quoting the well-known experiments of Dr. Beaumont on Alexis St. Martin, it may be said in general terms that a time varying between three and a-half and four and a-half hours, is usually required for the digestion of a meal of mixed food. In some cases six to eight hours, or even more, may be required, whilst fish and certain light articles of diet are digested by most people in about an hour.

We may say then, that in order to maintain health and vigor:

(1.) The food taken must be sufficient in quantity. This implies in the case of adults, from 25 to 30 grains of carbon, and from 1 to 1.5 grain of nitrogen for every pound of body-weight, but in the case of infants proportionally more of both.

(2.) The food must be of good quality and digestible. Although salt junk may be digested by the British sailor, the same food would probably mean starvation to the delicately nurtured child, or to the literary man who takes but little exercise.

(3.) The food should be properly cooked. Underdone meat may give worms. Overcooked meat is difficult to digest, is unpalatable, and often proves injurious.

It may be remarked that from 15 to 30 per cent., or on an average, about one-fourth of the weight, is lost in most methods of cooking meat. Therefore 8 ounces of raw meat will be about equal to 6 ounces of cooked meat.

(4.) There must be variety in an efficient diet scale. In addition to the carbon and nitrogen, some 200 to 600 grains of mineral matter, and some 5 to 6 pints of water are required;—in other words, there is needed from 2 to 3 pints of water in excess of that contained in the articles of food.

(5.) The intervals of feeding must not be too long. The very young infant requires the breast at least every two hours, or if only a few days old, every hour. Older children require food about every three or four hours during the daytime. Few adults can dispense with three meals per diem. A few thrive well on two, but most do better with four meals daily.

Having discussed these general questions we now proceed to consider—

I. The symptoms of starvation.
II. The time of death in starvation.
III. The treatment of starvation.
IV. The post-mortem appearances indicative of starvation.
V. The diseases arising from a deficient diet, or an improper quality of food.

I.—The Symptoms of Starvation.

In chronic starvation, hunger is not a marked symptom. On the contrary, a loathing of food is more frequent than a desire for food. Similarly in acute starvation, intense hunger appears to be a symptom of comparatively short duration.

Briefly summarizing the symptoms recorded, they appear to be those of great nervous depression. The pulse is usually slow and soft (*Cases* 35 and 36), the features collapsed (*Case* 36), although a flushed face has at times been noted (*Case* 35), the voice hollow (*Case* 36), and the breath offensive (*Cases* 35 and 36).

In the case of the Welsh Fasting Girl, Nurse Clinch "first perceived a peculiar smell about the bed on the sixth day of the watching." She says, "it was not like the usual smell of death, and I cannot describe what it was like." It was not urine, nor did it arise from

the feathers of the new bed, for "after the bed was changed I still perceived the smell."

Very often, in cases of starvation, the breath for some days before death has been described as unusually cold. A marked debility with great languor (*Case* 36), listlessness, irritability (*Case* 16), despondency and a tendency to start at noises or bright lights (*Case* 18), has been commonly observed.

In some cases the eyes are said to be fierce-looking, and the pupils widely dilated. The skin usually is harsh and dry, and if the person be plump before starvation, it will probably soon be found to hang in loose folds (baggy) over prominent bones. ("*Med. Press and Cir.*," 1880, I., p. 210.) Very frequently, especially in chronic cases, the skin becomes covered "with a brownish filthy-looking coating, almost as indelible as varnish." One most marked characteristic of slow starvation is the acutely lined character of the wrinkles on the face, assuming, in fact, the appearance of deeply cut lines. The hair in chronic cases has been recorded as growing unusually long and rapidly over the body. ("*Med. Press and Cir.*," 1880, I., p. 210.)

There is often distressing palpitation, with *tinnitus aurium*, illusions and double vision (*Cases* 18 and 36), and even temporary blindness. (*Case* 6.) Great emaciation (showing itself especially at the nates, the thighs, the orbits, the neighborhood of the zygoma, and in the neck and thorax) occurs, especially in the later stages, and arises not so much from loss of fat as from actual wasting of the muscles. (*Cases* 2, 9, 13, 15, 15*, 23, 31, 35, 43, and 47.)

The muscular weakness may become so great that the person is unable to move from actual loss of power (a kind of paralysis) in the lower extremities (*Cases* 8**, 17, 27, 36), although such a result of starvation is by no means of uniform occurrence. (*Cases* 15, 31, and 39.) The temperature, slightly raised at first, usually sinks in the later stages. As a rule the mouth is dry, parched, and full of thick tenacious saliva, and the thirst intense. (*Cases* 23, 32, 34, and 35.)

The pains and irritation in the stomach, sometimes increased and sometimes relieved by pressure, are usually troublesome (*Cases* 31 and 36), although they are not of such a nature as to give the patient the sensation of hunger, but rather the reverse. In some chronic cases, convulsions (*Cases* 6 and 35), ending in dementia (furious delirium) (*Cases* 8* and 18) have occurred. Dr. Taylor ascribes this latter condition either to a tropical climate, or to the person drinking wine, spirit, salt water, or urine during the period of abstinence. (Rostan and Orfila, "*Cours Elémentaire d'Hygiène*," I., p. 283, etc., and

"*Médecine Légale*," I., p. 415; "*Medical Times and Gazette*," March 30th, 1861, p. 344.)

In some cases a train of nervous affections have had their ending in fatal coma (*Cases* 6 and 34), whilst in others, the mind has remained clear, and the intellect unclouded, to the very last. (*Cases* 10, 11, 15, and 15*.)

As a rule the bowels are exceedingly costive (*Cases* 10, 13, 23, and 36), and sometimes cease to act altogether. (*Cases* 6, 8, 8*, 9, and 31.) If they act at all, the fæces are usually small, hard, dark colored, and dry lumps, that cause much pain in the passing. The state of the urine depends somewhat on whether the person abstains from liquids as well as solids, and the quantity of liquid taken. Thus in some cases no urine seems to have been passed at all (*Cases* 6 and 8); in others what was passed was very pale and scanty (*Cases* 8*, 9, 10, 23, and 26); whilst again, in other cases, it has been recorded as high-colored, becoming very turbid on standing,—in other words very concentrated. A peculiar aromatic odor of the urine has been noted. The absence of albumen has also been remarked. (*Cases* 9 and 31.)

It will generally be noted that the body feels cold, and that occasionally purple extravasations (petechiæ) are to be found on the skin. (Orfila, "*Cours de Méd. Légale*," p. 415.) The mucous membrane of the outlets of the body (anus, nostrils, vagina, urethra, etc.), are frequently red and inflamed.

Dr. Cornish (Surgeon-Major) gives the following as the conditions resulting from chronic starvation:—(*a*) emaciation and loss of bulk;—(*b*) disappearance of the subcutaneous fat, and in females absorption of the mammæ;—(*c*) anæmia;—(*d*) swollen and ulcerated gums (this condition of *land scurvy* occurred in a large proportion of the cases noted);—(*e*) great tendency to ulceration and sloughing on the receipt of slight injuries;—(*f*) anasarca (in a considerable number of the cases);—(*g*) dry scurvy, with pigmented patches on the skin;—(*h*) bristly discolored hair;—(*i*) an aspect of great hebetude and depression;—(*j*) a crouched attitude, the limbs being gathered in on a sunken abdomen. ("*London Med. Record*," 1879, p. 170.)

Some of these symptoms, require more detailed notice:—

(*a*.) *The pulse.* At first this is a little quickened, but in the later stages it becomes slower (*Cases* 23, 31, 35, 36). On the approach of danger, it usually becomes greatly quickened. On this point Dr. Fowler, in his "*History of the Welsh Fasting Girl*," remarks, "Assuming the average pulse of Casper's prisoner (*Case* 36) to have been from 70 to 75, as it ordinarily is at that age, we get on the fifth day

of absolute starvation a rise of from 13 to 18 beats per minute, which, on the eighth day is augmented by 8, or in all about 21 to 26 beats over and above its natural rate. On the second day of the fasting, Sarah Jacob's pulse had increased 14 beats, on the third 26 beats, on the fifth 54 beats, and on the seventh day 74 beats, in rapidity. Sex and temperament may have something to do with this dissimilarity." Dr. Fowler accounts for the apparently normal rate of 76 on the tenth day in Casper's prisoner, from his having taken some sugar and water.

In the case of imprisoned pitmen, an impure atmosphere no doubt contributes to the slow pulse rate.

(β.) *Temperature.* Chossat's experiments on the temperature in starvation, will be found in his "*Recherches expérimentales sur l'inanition*," a memoir presented to the Academy of Sciences in 1843. (See also Wunderlich on "*Temperature*," New Syd. Soc.'s Translat., pp. 135–6.) The temperature in starvation is generally lowered, but to no great extent in the earlier stages. Thus on the fifth day the temperature in Case 36 was recorded as normal. The general depression is rarely more than from 0.5° to 2° F. (= 0.3° to 1.1° Cent.). Forgetfulness of this fact led some of the medical men wrong in Sarah Jacob's case. It is very probable that in certain stages of fasting, there is a slight increase of temperature [pyrexia]. The loss of temperature is most remarkable, however, on the last day of life, when it sometimes amounts to several degrees (collapse). But even this is not always the case, for I have myself seen a case of chronic starvation where the temperature was normal to the very end. Dr. Carpenter shows that in Chossat's experiments, the daily *variation* or *fluctuation* of temperature is greatly increased.

When food is taken after prolonged fasting the temperature rapidly rises.

(γ.) *Loss of weight.* In starvation, loss of weight is inevitable (*Cases* 2, 9, 13, 15, 15*). Thus in Case 31 (one of voluntary starvation), the man lost seven pounds during the first six days of his fast (= 1.17 pound per day). Dr. Tanner's loss of weight during his forty days' fast, was said to be at the rate of 1 lb. per day (*Case* 48). It was the appeal to the balance that proved the imposture in Case 2.

But it is important to consider to what extent loss of weight, consistent with life, may extend:—

In Chossat's experiments ("*Recherches expérimentales sur l'inanition*," Paris, 1843, p. 21), the average loss of weight that occurred in healthy warm-blooded animals between the commencement of starvation and death, was 40 per cent. In other words, an animal died without the intervention of disease, when it had lost two-fifths of its

body-weight. The results obtained show considerable variation depending chiefly on the amount of fat, those animals losing most in which the fat was in the greatest abundance, whilst at the same time they lived the longest.

Taking 40 per cent. as the mean, M. Chossat obtained the following curious results as regards the relative diminution of the several tissues and organs of the body:—

Parts which lose *more* than 40 per cent.		Parts which lose *less* than 40 per cent.	
Fat	93.3	Muscular coat of stomach	39.7
Blood	75.0	Pharynx and œsophagus	34.2
Spleen	71.4	Skin	33.3
Pancreas	64.1	Kidneys	31.9
Liver	52.0	Respiratory apparatus	22.2
Heart	44.8	Osseous system	16.7
Intestines	42.4	Eyes	10.0
Muscles of locomotion	42.3	Nervous system	1.9

Assuming these results to be applicable to human beings, it follows that if a man weighing 144 lbs. loses weight continuously at the rate of 24 ozs. per week (= 6 lbs. per month), he must die within twelve months;—or given a normal weight of 120 lbs. a person could not live three years with an annual loss of 20 lbs. The enormous importance of these facts to practical medicine, has been dealt with in great and careful detail by Dr. Dobell. (See "Loss of Weight, Blood Spitting, and Lung Disease.")

In the Staunton case (*Case* 41), the woman after death weighed 74 lbs. Assuming 120 lbs. to have been her normal weight (calculated from her height), it follows that she lost 46 lbs., or as nearly as possible two-fifths of her weight—a result strictly in accord with Chossat's experiments. But it would seem from recorded cases that the body-weight in human beings may fall below 40 per cent. Thus in *Case* 15, one of enforced fasting by disease, the body-weight fell in ten months from 120 to 60 lbs., and during the succeeding seven months (at the end of which time the man died) to 40 lbs. The case is remarkable from the circumstance that the man walked about to within three days of his death. One cannot help thinking there must have been some error in the weighing.

Again, in famine, Dr. Cunningham ("*London Med. Record*," 1879, p. 171) records that in a series of observations made by him, the loss of body-weight fell from 20 to 40 per cent., fat and blood (the latter in bulk rather than in any special constituent) disappearing in greater proportion than other tissues. The spleen, pancreas, liver, heart, and intestines underwent a high degree of waste (Chossat, Cornish, etc.).

A very important fact bearing on this subject is the following: The tissues are prone, in chronic starvation, to undergo fatty changes and subsequent absorption (Cunningham), this change specially affecting the mucous and submucous tissues of the intestines. This condition leads to destructive desquamation of the epithelium, thinning of the intestines, and various degrees of ulceration, so that in some cases the muscular coat is found to constitute the lining membrane of the intestine. These changes are also observed, although in a lesser degree, in the skin, liver, and kidneys. (See illustrative of this (Mr. Lucas) "*Lancet*," August 9, 1879.)

When food, in proper quantity and quality, is taken after a period of starvation, the body-weight increases. Thus in *Case* 43 a starved child, when properly fed, gained 3 lbs. in four days, and 10 lbs. by the end of the month, whilst in *Case* 47 a starved girl, æt. 13½, gained weight at the rate of 5 ounces per day for 129 days. The increase of weight in such cases is gradual, because the powers of assimilation become weakened by the fast. And the longer the fast, the more gradual the increase, because the weaker is the digestive capability from an increasing atrophy of the digestive organs, and more especially of the pancreas. In *Case* 31, one of acute starvation in a healthy man, the loss of weight resulting from a ten days' fast was said to have been made up by three days' food.

In *Case* 31 the urea excreted during the third, fourth, and fifth days of the fast amounted to 294.6 grains per day (or 2.9 grains per lb. body-weight), whilst on the fourth day the quantity excreted was equivalent to that passed on the third and fifth days together. Ranke fixes 2 grains of urea per lb. of body-weight as the quantity daily excreted during inanition.

And here the important question arises, viz., what ought to be the weight at a given age?[1] The *average* weight at different periods of life will be found in a Table on page 145.

[1] The mean weight of man is (M. de Parville "Union Méd.," Sept. 2, 1880) about 70 kilos. This is made up as follows:—

Muscles and accessories	31.0 kilos.
Skeleton	12.4 "
Skin	5.0 "
Fat	12.0 "
Brain	1.4 "
Thoracic viscera	1.2 "
Abdominal ditto	4.0 "
	67.0 "

The remainder consists of blood.

The total weight of the liquids is 40 kilos., and of the solids 30 kilos.

In 24 hours the body, he states, loses 2 kilos. 700 grms. of water, 250 grms. of car-

In using tables of this kind, however, great allowance must be made for premature birth, for congenital syphilis (which has a tendency to retard growth, development, and puberty), and for diseases such as phthisis, tabes mesenterica, recent attacks of fever, etc., all of which would tend to produce a less weight than the average of normal healthy cases, and on the othar hand for obesity as an influencing condition in the opposite direction.

Given, however, a case such as *Case* 47, where a girl of 13 was found to weigh only 35 lbs., whilst her weight at that age should have been 71.5 lbs., showing a deficiency of 36.5 lbs.,—and further taking into consideration the fact that when properly fed her body-weight gradually increased, the loss of weight must be regarded as strong *primâ facie* evidence of insufficient food having been allowed.

But important considerations arise when we regard loss of weight and consequent emaciation forensically :—

And *first*, *there may be great emaciation, without starvation being the cause of the emaciation.* Thus in *Case* 42 the medical evidence was that the child died of starvation, although it was admitted that it suffered from extreme diarrhœa. The fact that diarrhœa might itself produce emaciation and bloodlessness seems to have been overlooked, and this although all the time food was being given. (Chossat, p. 153.) Again in the Staunton case (*Case* 41) the emaciation was undoubtedly extreme ; but the question here was, not the existence of emaciation, but, did the emaciation necessarily indicate starvation ? Good authorities (Drs. Greenfield, Bristowe, etc.) considered the death of this woman was probably due to tubercular meningitis, and the post-mortem undoubtedly supported this view. Dr. Greenfield has shown that emaciation may result from this disease. ("*British Med. Journal*," Oct. 20, 1877.) The real fact is, emaciation does not prove starvation, because emaciation may occur where the supply of food has been unlimited.

But *secondly*. *There may be very little emaciation, and yet the death result from starvation.* In the case of the Welsh fasting girl (*Case* 1) it was noted that at the time the strict watch was instituted, the girl was *plump*. She died on the eighth day of the watch. The counsel for the defence made much of the fact—as proof against the theory of the prosecution that the death of the girl was due to starva-

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bon, 25 grms. of nitrogen, and 25 of mineral matter. To balance expenditure, the body needs 500 grms. of dry aliment, 650 grms. of oxygen, and 2,300 grms. of water. In the prolonged fast of a fat man, he has at his disposal about 15 kilos., and he loses daily about 300 grms. of carbon and of nitrogen. In 15 kilos. we have 50 times 300 grms.—that is, absolute exhaustion would not take place for 50 days.

tion—that a thick layer of fat was found in some parts of the body, and that no thinning or attenuation of the intestines was discovered. But the truth is, that these conditions, as Dr. Fowler has pointed out, are perfectly consistent with death from starvation in the case of a "*plump*" girl, who dies after eight days' entire deprivation of food. (Dr. Fowler, "*Lancet*," July 30, 1870.) The absorption of fat (whether complete or not) will depend on the amount of fat previously existing, and on the interval between the commencement of the process of starvation and the death. Where *great* emaciation occurs is after *long* deprivation from food (chronic cases), but not necessarily in acute cases. (See Fowler.)

Thirdly. An important question may arise as to the muscular power possible in cases of starvation. On this we note that in most instances, exhaustion is such that physical exertion is rendered impossible. (*Cases* 17, 27, and 36.) In *Case* 36 the exhaustion was so great on the eighth day, and in *Case* 27 on the eleventh day of the fast, that the men (adults) were unable to move. On the other hand, in *Case* 15, one of *chronic* starvation lasting for 17 months, the man was able to walk about within three days of his death, whilst in *Case* 31, one of *acute* starvation lasting 5½ days, the man is recorded as taking his usual exercise for an hour daily. Similarly, Dr. Tanner is recorded as taking daily exercise during his voluntary fast of 40 days. (*Case* 48.) On this question we would note that the presence or absence of scurvy would materially affect results.

In *Case* 39 a question bearing on this point is recorded. If the starvation for the 28 days had been complete, it is doubtful whether sufficient strength could have been retained to perform the acts stated; still, even under such circumstances, it is not absolutely impossible. But the possibility is rendered a probability, considering that some food had undoubtedly been taken during the time. Every case must be considered on its merits, and the chief point in such questions is, what was the condition (*i.e.*, plump or thin) of the person on starting.

II.—The Time of Death in Starvation.

The factors to be considered in answering the question, How long does starvation take to kill? are numerous. Of these may be mentioned—

(*a.*) *Condition of Body.*—Thus, other things being equal, fat persons bear privation longest. (*Case* 1.)

"There is a well-known case of a fat pig which was buried in its sty for 160 days, under thirty feet of the chalk of Dover cliff, which was dug out alive at the end of that time, reduced in weight from 160 to 40 pounds, or no less than 75 per cent." ("*Transactions of Linnæan Society*," Vol. XI., p. 411.) This extraordinary prolongation of life may be attributed to the retention of the *heat* of the body by the non-conducting power of the chalk, also to the retention of its moisture by the saturation of the air in the immediate vicinity, and to the restriction of the animal's movements. (Carpenter's "*Physiology*," Note to p. 94; Horn's "*Description of Dover*," 2d ed., 1819, p. 24.)

(*β.*) *Access to Fresh Water.*—All agree that life is prolonged if the sufferers from want of food can obtain water. Of this fact, the illustrations are numberless.

It is stated that in experiments on starvation tried on horses, it was found that they would hold out for 25 days if supplied with water, but that they could barely live 5 days if no water was given them. (Mr. G. Fleming, in "*Veterinary Journal*," September, 1880.)

(*γ.*) *Age.*—The statement of Hippocrates[1] that "The old bear want of nourishment *best;* those who have attained the middle period of life the *next in degree;* those who have just arrived at puberty are *less* able to endure it; but that of all ages, childhood is the *least* capable of sustaining hunger, and of children the more lively are the *least* capable," seems borne out both by experience, and by the experiments of Chossat and others. It takes very little to kill an infant by keeping it away from the breast, or if it be a little older by giving it insufficient or improper food.

(*δ.*) *Warmth* will, to a limited extent, take the place of food.

(*ε.*) *Hybernation.*—During hybernation, the digestive, respiratory, circulatory, and nervous functions, if not suspended, are more or less in

[1] Bellott's translation, "Aphorisms," Lib. I., No. 13:—"Γέροντες εὐφορώ τατα νηστείην φέρουσι· δεύτερον, οἱ καθεστηκότες· ἥκιστα μειρακια· πάντων δὲ μάλιστα παιδία· τουτέων δὲ αὐτέων ἃ ἂν τύχη αὐτὰ ἑαυτῶν προθυμότερα ἐόντα."

abeyance (Vol. I., page 28). There are (as we have elsewhere said) conditions of human hybernation (catalepsy, hysteria, etc.) occasionally observed, more especially in young girls, that may account somewhat for the remarkable stories of their long fasts. Clearly, however, at night-time and during sleep much less food is required than during the activity and bustle of the day, indicating that the requirements of the body for nourishment under such conditions are lessened.

The long period that the insane will at times subsist without food is remarkable.

(ζ.) *The Atmosphere in which the Person is placed.*—Thus in the case of imprisoned miners, no doubt life may be prolonged under privation, the vital functions being materially lowered from the air containing an excess of carbonic anhydride. (*Cases* 17 and 23.)

(η.) *Previous and Existing Health.*

(θ.) *Whether the Privation is associated with general Ill-treatment.* (*Case* 46.)

(ι.) *Whether the Fast is complete or not, and whether subject to medicinal interference.*—Thus in *Case* 6 morphia injections seemed to act as food.

Of the recorded cases of death from starvation (without taking into account, however, access to water) the following are the periods of death:—

From the	7th	to 10th	day	inclusive,	4	cases.	(*Cases* 1, 16, 32, and 33.)
"	11th	" 15th	"	"	9	"	(*Cases* 18, 23, and 34.)
"	18th	" 30th	"	"	4	"	(*Cases* 18, 27, and 40.)
"	31st	" 40th	"	"	2	"	(*Cases* 8 (?) and 8*.)
"	41st	" 50th	"	"	3	"	(*Cases* 7*, 15*, and 38.)
"	51st	" 60th	"	"	3	"	(*Cases* 10, 28, and 35.)

Of men incarcerated in mines or other close places, recovery is recorded after 8 days (*Case* 20); after 9 days with water and in a compressed atmosphere (*Case* 24); after 12 days with water (*Case* 23); after 14 days (*Case* 21); and after 23 days (*Case* 17).

Recovery is also mentioned as occurring after 20 days (*Case* 22); after 28 days (*Case* 39); after 40 days (*Case* 48); and after 90 days (*Case* 14). In each of these cases the person had access to water. A case is also recorded by Dr. Willan, in Dr. Winslow's paper already referred to, of a 61 days' fast with water, where death occurred on the eleventh day after commencing to take food. In *Case* 25, ten out of thirteen men survived after 12 days without either food or water.

In those who have attempted voluntary starvation, it was observed in one case that the person was rapidly sinking at the end of 9 days, but recovered on being compelled to take food (*Case* 2); and that in two other cases, the individuals were unable to abstain longer from food than 5½ days in one case (*Case* 31), and 11 days in a second (*Case* 36).

We need only note that there are many cases on record of fasts occupying months and even years, all of which, however, must be accepted for what they are worth. (*Cases* 3, 6, 7, 8 (¹), 9, 11, and 29.) The extraordinary fasts of the Faqueers in the Punjaub appear to be an exhibition of conjuring. ("*Medical Times and Gazette,*" 1870, I.)

III.—The Treatment of Starvation.

This briefly is as follows:—When food has to be administered after long privation, it should at first be given in small quantities, and in a form easily assimilable, such as beef-tea, good soup or broth, eggs, milk, wine and water, or weak spirits, gradually going on to fish, meat, bread, and vegetables. If treatment is not effected cautiously, there is considerable risk of injury. The popular but fallacious idea is, that in such cases you can scarcely give too much!

IV.—The Post-mortem Appearances indicative of Starvation.

Our knowledge of these is mostly derived from chronic cases.

Rigor mortis has been recorded as well marked. (*Case* 13.)

Condition.—In *Case* 1 (acute starvation) the body was plump. (See page 209.) In chronic cases the body is invariably shrunken and greatly emaciated, and there is an almost entire absence of fat. (*Cases* 6, 12, 13, 41, 42, and 45.) Sometimes one part becomes much more emaciated than another, as though the drain of the system centred itself on that part. (*Case* 7*.)

The Skin.—This is sometimes shrivelled, and emits a disagreeable odor (page 203); at other times it is covered with a coating of brown material. (Page 204.) As a rule, it is difficult to separate the skin from the subjacent muscles.

The Muscles are commonly soft, pale, and wasted. (*Cases* 13 and 35.)

The Brain has been variously recorded as healthy and firm (*Case* 1),

as pale and soft (*Cases* 35 and 45), and as congested. (*Case* 12.) Effusion on the surface was noted in *Case* 13.

Many years ago some of the prisoners at Millbank were put on a very spare diet, from which animal food was excluded. (Page 217.) At the post-mortem of those who died, "increased vascularity of the brain and its membranes, combined frequently with effusion of fluid into the ventricles and between the membranes" was found. Great injection of the membranes of the brain has also been recorded in cases of starvation. (*Cases* 1 and 12.)

The Lungs have been commonly recorded as healthy, although contracted. (*Cases* 1, 12, and 35.) Sometimes they have been said to be somewhat pale and bloodless. (*Case* 45.)

The Heart is not generally quite empty. Sir Thos. Watson says: "After death by starvation, the heart is not found to be so much contracted, nor so nearly empty, as after death by sudden and copious hemorrhage." ("*Principles and Practice of Physic*," p. 65.) It is, however, usually more or less contracted (*Cases* 12 and 41), and sometimes soft and bloodless. (*Cases* 30 and 45.)

The Thymus Gland in children (and in animals generally) that have been badly fed is usually of large size, and during life very persistent.

The Œsophagus.—This is usually small and contracted. (*Cases* 6 and 38.)

The Stomach.—This has been recorded as natural (*Case* 35), as small and contracted (*Case* 6) (a condition in which we have ourselves usually observed it) as corrugated (*Case* 12), as loose and flabby (*Case* 28). As regards its contents, it has frequently been found to contain a little dark gelatinous fluid. (*Cases* 1 and 6.)

The Small Intestines.—These are generally contracted both in their length and calibre, and are commonly thin and transparent. (*Cases* 12, 28, 30, 42, and 45.) This was seen in a very marked degree in those that died during the Irish famine. They are sometimes very friable. (*Cases* 13 and 35.) An injected condition has also been recorded. (*Case* 35.) Sometimes they are empty (*Cases* 1, 30, and 41), but at other times they contain a little dirty mucus. (*Case* 6.) Sometimes they appear to be distended with gas.

It must be remembered, however, that a thinning of the intestines occurs in all long-continued wasting diseases. On the contrary, in acute starvation the intestines may appear normal. (*Case* 1.)

The Large Intestines are usually transparent, and sometimes normal. (*Case* 35.) They frequently contain hard fecal matter. (*Cases* 1 and 35.) Sometimes they have been found distended with flatus.

(*Case* 30.) The rectum has been found congested (*Case* 41), and to contain hard lumps of fæces, which in one case were said to have been coated with a white-looking mucus. (*Case* 6.)

The Omentum is usually transparent. (*Cases* 41 and 46.)

The Liver.—This is usually healthy (*Cases* 1, 12, and 13), but contracted. (*Case* 41.) In one case (*Case* 45) it was recorded as congested.

The Gall-Bladder is usually full (*Cases* 1, 6, 12, 13, 28, 35, and 41), and there is often cadaveric exudation of bile. (*Cases* 13 and 30.) In Case 45 the gall-bladder was recorded as empty.

The Kidneys.—These have been recorded as healthy. (*Cases* 1, 12, 13 and 45.) In *Case* 6 they were said to have been congested, and in other cases pale.

The Spleen has been recorded as healthy. (*Case* 1.)

The Pancreas.—This is invariably atrophied, and in some cases to such an extent as almost to be wanting. (*Case* 49.)

The Bladder is invariably empty (*Case* 1), and sometimes much atrophied. (*Case* 6.)

The Uterus.—Softness and relaxation of the tissues of the uterus often result from chronic starvation and defective nutrition. Hence follow flexions. (See Graily Hewett, "*Lancet*," 1879, I., p. 38.) (*Case* 6.)

A contracted state of the stomach and bladder, a shrunken and transparent condition of the intestines and omentum, with a more or less atrophied, but otherwise healthy condition of the viscera (*Case* 49), appear to be the prominent post-mortem symptoms remarked after death from starvation.

V.—Diseases arising from a Deficient Diet or an Improper Quality of Food.

We note first of all, that food of bad quality may produce actual symptoms of acute poisoning.

Some forms of *vetch* (*Lathyrus sativus* and *L. cicera*), used as food, appear at times, when taken in large quantity, to cause paraplegia. Bad results (ergotism) also result from the use of grain affected with ergot.

Pellagra, a red eruption attended with great debility, nervous exhaustion, and pigmentation of the skin, is believed to be caused by the sporules of a fungus [*sporisorium maidis*] attacking maize, the chief food of the peasants in Lombardy. Other affections have been ascribed to the use of food of bad quality or all of one kind, and that

kind not sufficiently nutritious. For example, the exclusive use of rice and of potatoes as articles of diet are known to favor, if not to produce ulceration of the cornea, so common amongst the Hindoos. Shell-fish appear to induce urticaria in some persons, even when the fish are of good quality.

Gout is known to be greatly favored by the use of malt liquors and imperfectly fermented wines, and by indulgence in a highly nitrogenized diet without sufficient muscular exercise. Rheumatism is ascribed by some to the mal-assimilation of the farinaceous and starchy foods. Dr. Carpenter ascribes the scrofulous diathesis to the absence of oleaginous articles of food.

The power of sustaining enormous blood-lettings with little inconvenience, apparently possessed by some of our ancestors, has been ascribed to their liberal use of flesh meat. If this were the cause (and there is little reason to doubt it), we can understand how useful, even medicinally, were the frequent fasts prescribed by the church.

We may now consider what are the diseases commonly resulting from the combined effects of deficiency and of an improper quality of food :—

(*a.*) *Sea scurvy* (*purpura nautica vel hæmorrhagica*). Although fatigue and other causes may predispose to this disease, it is certain that the absence of fresh vegetables, of fresh fruits, and of fresh meat from the diet is the principal cause. Of the foods mentioned, the most important is unquestionably fresh vegetables. As early as 1757, Dr. Lind showed the efficacy of oranges and lemons in preventing scurvy. Forty years, however, elapsed before the Government made the use of lime-juice compulsory, as it now is under the Merchant Shipping Act, in the navy.[1] It is not yet known how lime-juice acts in preventing the disease. Potatoes and other fresh vegetables, especially the cruciferæ, and most fruits appear to have almost a similar power. Fresh meat alone is not nearly so efficacious.

(β.) The famine-stricken are often carried off by *Land purpura* associated either with general cachexia and feeble vital resistance, or with *diarrhœa and dysentery*, the motions containing undigested food. Dr. Cunningham points out that in famine, relief to be of use must be

[1] *Lime*-juice is the juice of the *Citrus limetta*, while *lemon*-juice is derived from the *Citrus limonum*, or lemon-tree. Although the linden (sometimes called "lime-tree") has antiscorbutic properties, it is quite a different plant from the one named above, which is known as the lime-tree in the West Indies. The author cannot express too strongly the necessity of a careful examination of the samples used, to determine whether they be the true juice or manufactured articles.

early, the tissues not being ready, as Bauer supposed, to resume their functions so soon as food is provided, but assume a degree of inanition in which the power of assimilation is abolished. ("*London Med. Record,*" 1879, p. 171.)

(γ.) It is said that in Ireland *ophthalmia* is a frequent result of starvation. ("*British Med. Journal,*" December 25th, 1880, p. 1044.) It is important to note that cases of starvation are often associated with overcrowding, and that such a complication must materially affect the result.

It would appear that although famine may not necessarily originate any specific pestilence, it greatly aggravates any epidemic that may exist within the famine area.

(δ.) *Rickets*, and stunting of the bones, appear to be due, if we may judge from the remedies which prove beneficial, to a deficiency of lime-salts, phosphates, fatty constituents, and iron in the diet. ("Lancet," 1874, I., p. 560.)

(ε.) *Relapsing fever* and *typhus* are greatly favored by an insufficient diet. The former of these has gained the name of *famine fever*.

(ζ.) *Dysentery* and *diarrhœa* (English cholera), are also liable to be prevalent where the diet is deficient.

(η.) In cases where patients have been starved and otherwise badly treated, such as recklessly exposed to cold, *chilblains* are often very severe. (*Case* 47.)

(ι.) It has been suggested that starvation may produce *insanity*. (*Vide* "*Lancet,*" 1874, I., 714.)

As an illustration of the evils arising from a deficient diet, the following case is instructive:—In 1823 the prisoners in Millbank Penitentiary had their allowance of food suddenly reduced from about thirty-two ounces of dry nutriment daily to 21 ounces, animal food being entirely discontinued. Although the prison was cold, and situated at a low level and in a marshy district, it had been previously considered healthy. But soon after this change of diet, the health of most of the inmates gave way. They lost color, flesh, and strength; diarrhœa, dysentery, and scurvy set in, and lastly, adynamic fevers, headache, vertigo, convulsions, maniacal delirium, and sometimes apoplexy. The smallest loss of blood produced fainting, which was often fatal. Out of 860 prisoners, 437, or 52 per cent. were thus affected. It was found that those employed in the kitchen, who had 8 ounces of bread extra per diem, were almost exempt (only three being attacked) and further that the addition of 8 ounces to the daily amount of vegetable food, and half an ounce to the animal, greatly facilitated

restoration to health. (See Dr. Latham on "*Diseases in Millbank Penitentiary*," 1824; Carpenter's "*Physiology*," pp. 96–7.) (Page 214.)

During the American Civil War, Dr. Jones made similar observations on 30,000 Federal prisoners confined in Camp Sumpter. Here the diet was only one of the causes of sickness, but it was, undoubtedly, a powerful one. Diarrhœa, dysentery, scurvy, and hospital gangrene prevailed. (See Austin Flint's "*Physiology of Man*," Vol. II., p. 39, 1867, and the "*Ann. d'Hygiène*," Jan., 1849, for similar observations at the Maison Centrale of Nîmes, by M. Boileau-Castelnau.) Another experiment on a gigantic scale was unavoidably made during the siege of Paris in 1870. (*Case* 19.)

The general effects of the deficiency of food are well sketched by Dr. Letheby. "A deficiency of food, especially of the nitrogenous part, quickly leads to the breaking-up of the animal frame. *Plague*, *pestilence*, and *famine* are associated with each other in the public mind, and the records of every country show how closely they are related. The medical history of Ireland is remarkable for the illustrations of how much mischief may be occasioned by a general deficiency of food. Always the habitat of fever, it every now and then becomes the very hot-bed of its propagation and development. Let there be but a small failure in the usual imperfect supply of food, and the lurking seeds of pestilence are ready to burst into frightful activity. The famine of the present century is but a too forcible illustration of this. It fostered epidemics which had not been witnessed in this generation, and gave rise to scenes of devastation and misery which are not surpassed by the most appalling epidemics of the middle ages. The principal form of this scourge was known as the contagious famine fever (typhus), and it spread, not merely from end to end of the country in which it had originated, but breaking through old boundaries, it crossed the broad ocean, and made itself painfully manifest in localities where it was previously unknown. Thousands fell under the virulence of its action, for wherever it came, it struck down a seventh of the people, and of those whom it attacked one out of nine perished. Even those who escaped the fatal influence of it, were left the miserable victims of scurvy and low fevers. Another example, not less striking, of the terrible consequences of what may be truly called famine, was the condition of our troops during the early part of their sojourn in the Crimea in 1854. With only just enough of food to maintain the integrity of the system at a time of repose and of ordinary temperature, they were called upon to make large muscular exertions, and to sustain the warmth of the system in the midst of severe cold."

ILLUSTRATIVE CASES.

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1. **R. v. Jacob and Wife.**—(*Carmarthen Summer Assizes,* 1870.)—(Case of Sarah Jacob, known as the Welsh Fasting Girl.—See "History," by Dr. Robert Fowler.)—S. J. was born May 12th, 1857. Had a dyspeptic attack in February, 1867, and, about a year after, a mild attack of scarlet fever. During this six weeks' illness, she had some convulsions of a tetanic character (opisthotonos), "with rigidity of the left leg," and "for nearly a month, of all the muscles." During the same year there appears to have been repeated abstinence from food for longer or shorter intervals. But from October of this year till her death on December 17th, 1869 (a period of two years, two months, and one week), it was affirmed that she ceased to take any food! All this time, however, except the last week, she continued plump, and even gained flesh. During the last week an efficient watch was kept, the supervision commencing at 3 P.M. on December 9th, 1869. She died on the 17th at a few minutes past 3 P.M. She was therefore entirely without food for seven days. The father and mother were tried and convicted of causing the death of their child by criminal negligence. The father was condemned to twelve months' imprisonment, and the mother to six months. The medical men who accepted the responsibility of superintending the watching, were summoned to appear before the magistrates on the charge of "killing and slaying Sarah Jacob," but were acquitted, partly because neither the nurses nor the committee appear to have asked their advice, but chiefly, no doubt, because of the humanity of one of their number.

Post-mortem appearances.—The body plump and well-formed, with signs of incipient puberty. Beneath the skin of the chest and abdomen, was a layer of fat about three-fourths of an inch in thickness. The brain was healthy and firm, but the membranes were much injected. Thorax healthy. The stomach contained about three teaspoonfuls of dark gelatinous fluid, having a slightly acid reaction to litmus paper. The small intestines were empty, but the colon and rectum contained about half a pound of hard fæces. It was thought that the fæces might have been there for a fortnight or even longer. Liver healthy. Gall-bladder considerably distended with bile. Kidneys and spleen healthy, and the blad-

der empty. On looking at the girl's shoulders and armpits, the right shoulder was found to be much more prominent than the other, the left armpit being sufficiently hollow to contain a half-pint bottle. [Dr. Fowler, when he first saw her, was of opinion that the girl was a night-feeder, and that the parents were themselves deceived at first. Discovering that the thing could be made profitable, they were afterward tempted to carry on the imposture.] (Pages 190, 191, 203, 205, 206, 209, 210, 212, 213, 214, 215.)

2. **"Wilson's Wonderful Characters," and "History of Tutbury," pp. 321–2.**—(Case of Ann Moore, of Tutbury.)—About sixty years ago, at Tutbury (or Tetbury), in Staffordshire, certain respectable inhabitants of the place volunteered to discover whether or not Ann Moore, a woman about middle age, subsisted, as was declared, without the ordinary nutriment of her kind. The watch was continued for about three weeks, when it was publicly proclaimed that the Tutbury woman "lived entirely without food." Her emaciation was said to be so extreme that the spinal column could easily be felt through the abdominal walls. Her distate to aliment, it was alleged, resulted from a nausea and disrelish produced by washing the linen of a person afflicted with ulcers. In consequence of the *éclat* derived from the unsuccess of the watchers, numerous visitors, some from long distances, visited Ann Moore during the next two (or, according to others, six) years, leaving, of course, their donations to the extent of about £250. [Beck says, on the authority of Dr. Henderson, that she had invested a sum of £400.] In April or May, 1813, the woman consented to another watching process being instituted, provided the Watch Committee was composed of magistrates, clergymen, and medical men. Amongst these were Sir Oswald Mosley, Legh Richmond, Dr. Fox, and his son Francis, of Derby, and many other gentlemen of the neighborhood. Two were always in her room day and night. At the suggestion of Mr. Francis Fox, the bedstead, bedding, and the woman in it were placed on a weighing-machine, which resulted in showing that she regularly lost weight daily. At the expiration of the ninth day of this strict watch, Dr. Fox found her evidently sinking, and told her she would soon die if she did not take food. After a little prevarication the woman signed a written confession, allowing she was an impostor, and had "occasionally taken sustenance for the last six years." She also stated that at the first unsuccessful watch of three weeks her daughter had contrived, when washing her face, to feed her every morning by using towels made very wet with gravy, milk, or a strong solution of arrowroot; and had also with every kiss managed to convey certain portions of sugar from mouth to mouth." (Pages 190, 191, 204, 206, 212.)

3. **British Med. Journ., May 28, 1870.**—(*Dr. Henry Barber.*)—

Two cases of long-continued abstinence from food, combined with hysteria and lethargy. One of these continued for eleven months, and the second for twenty-six weeks!! They were probably night-feeders at first. One case died. (Pages 190, 213.)

4. **British Med. Journ., July 16, 1870, p. 57; Fowler, p. 296.**—(*Dr. Ogle.*)—Cases of hysteria with pretended fasting. (Page 190.)

5. **Fowler, p. 284.**—Account of the Shottisham Angel, Elizabeth Squinel, the imposture being detected by a proposal to fire the house. She afterward married. (Pages 190, 191.)

6. **British Med. Journ., Feb. 2 and 9, 1878.**—(*Mr. Grant.*)—The Market Harborough Fasting Girl. Female, 17. Menstruated at 15½. In 1872 her digestion was disturbed, and she asserted that she was unable to swallow. From this attack she afterward recovered and returned to work. In 1873 the inability to swallow returned. She daily sucked, however, about 1 lb. of butter candy, and nutritive enemata, with hypodermic injections of morphia, were administered. In April, 1874, convulsions set in. At the end of the year she became insensible and lost her sight, which she recovered 1½ year afterward. The convulsions continued until her death (Dec. 14, 1877).

It seems that no food of any kind was taken, and for twelve months no urine or fæces passed. Hence it would appear from the report, that for a period of 3½ years this girl lived on morphia injections only (!).

Post-mortem.—Body much emaciated. Stomach and œsophagus small and contracted; bowels natural. Both the stomach and intestines contained a little dirty mucus. There were a few hard lumps of fæces, overlaid with whitish mucus, in the rectum. Gall-bladder full. No organic disease was found in the viscera. The bladder was so atrophied as to be scarcely distinguishable. The uterus was small, and the ovaries rudimentary. Kidneys congested. Brain and cord not examined. (Pages 190, 191, 204, 205, 212, 213, 214, 215.)

7. **Macmillan's Mag., April, 1871; British Med. Journ., May 6, 1871, and 1873, II., p. 353.**—Case of Louise Lateau (a case of ecstasy). She was said to have taken no nourishment for 20 months. (Pages 190, 213.)

7*. **Lancet, July 31, 1880.**—Female, æt. 60. Stout, and in a good position of life. Melancholia. For seven weeks she took nothing but water. Died on the fiftieth day. At death her limbs were found to be very thin, but the body fairly stout. (Page 213.)

8. Medico-Chir. Review, 1833 (from "Hufeland's Journal").—(*Dr. Schmacz.*)—(See "Med. Press and Circular," Nov. 7, 1877, p. 380.)—(1.) Female, æt. 31. For four years she took nothing solid, but merely water and whey. After this she refused even to take liquids. From March 18, 1822, to 1826 she had one motion, and passed urine three times only. A Medical Commission in Holland were appointed to investigate the case, but they could detect no fraud.

(2.) (Case of Anna Garbero.) On one occasion she is said to have passed 40 days without taking any solid or fluid, from inability to swallow. From September 25th to January 7th following, she neither ate nor drank, nor had any relief by bladder or rectum. The catamenia, though regular, were sparing. Death occurred from exhaustion. (Pages 205, 212, 213.)

8*. British Med. Journ., Aug. 7, 1880, p. 214.—(*Dr. Collins.*)—Female, æt. 80.—A thirty-three days' fast, during which an average of 2 ozs. of water was taken daily. Death. Delirium occurred for a few days about the end of the first week. She slept seven or eight hours out of the twenty-four. Urine scanty. No motions after the third week. (Pages 204, 205.)

8. British Med. Journ., Aug 2, 1880.**—(*Dr. J. C. Noyes.*)—Male, æt. 34. A forty-five days' fast. No water was taken during the last nineteen days. At the end of the forty-fifth day, the man was found to be demented, and the lower extremities paralyzed. (Page 204.)

9. Lancet, May 7, 1881, p. 755.—Report by Dr. Dougal on the Fasting Girl at Chapelton, æt. 14. Not menstruated. No solid food was said to have been taken between January 8, 1881, and the *date of report, May*, 1881. Takes water freely, and occasionally sweets. Very emaciated. Urine scanty and pale, but no albumen. No action of the bowels for eleven weeks. (Pages 191, 204, 205, 206, 213.)

10. Medical and Surgical Reporter (Philadelphia), April 1, 1876.—(*Dr. J. N. Norris.*)—Female, æt. 11. Suffering from diabetes, with hysteria. No food taken for 59 days and nights. Bowels acted once a week. Death. Mind clear to the last. During the fast, the amount of urine passed became less than normal. (Pages 191, 205, 212.)

11. Med. Press and Circular, Jan. 12, 1881, p. 36.—Female, adult. Said to have eaten practically no food for 2 years. The aggregate weight of solid food eaten during 1880 is said not to have amounted to more than 1 lb. Mind clear. (Pages 205, 213.)

12. Lancet, Nov. 3, 1877.—(*Mr. Whitcombe.*)—Female, æt. 55. Acute melancholia. Starvation and death from non-assimilation of food.

Post-mortem.—Great emaciation. Membranes of the brain and brain itself congested. Lungs, liver, and kidneys small and healthy, and gall-bladder full. Heart small and contracted. Stomach corrugated, and intestines shrunk. (Pages 191, 192, 213, 214, 215.)

12*. **Progrès Méd., Sept. 4, 1880.**—(*Dr. Bourneville.*)—A case of a boy, æt. 12, an idiot, who from the age of 2½ had from time to time fasted for periods varying from three to thirty-eight days. (Page 192.)

13. **British Med. Journ., Oct. 20, 1877, p. 559.**—(*Dr. Elliott.*)—Female, married, æt. 57. Lived in a state of great destitution for 5 or 6 months. Extreme emaciation. Bowels costive. Very ravenous when food was given her. Death.

Post-mortem (28 hours after death).—Rigor mortis well marked. Absence of all fat. The muscular tissue was pale and wasted. Omentum transparent. Intestines friable. Duodenum stained with bile. Liver and kidneys healthy, and the bile abundant. Effusion on the surface of the brain. (Pages 204, 205, 206, 213, 214, 215.)

14. **British Med. Journ., 1880, I., p. 574.**—(*Mr. Henson.*)—Female, æt. 71. Paralysis, Jan. 20th, 1880. Took no food, but occasionally a little cold water, from the attack to the date of the report (April 17th). (Pages 191, 212.)

15. **Canada Lancet, Nov., 1880.**—(*Mr. Kerr.*)—A case of enforced fasting from an œsophageal stricture produced by swallowing a weak lye. The patient's weight in ten months decreased from 120 lbs. to 60 lbs. During the last seven months of life enemata of milk and egg were all that could be given, and at death he weighed only 40 lbs. The intellect was clear to the end, and he walked about within three days of death. Prostration, with dyspnœa and syncope, caused the fatal ending. (Pages 191, 204, 206, 207, 210.)

15*. **Lancet, July 31, 1880.**—(*Dr. G. Stanley Murray.*)—Male, adult. Unable to take food from cancer of stomach. No nourishment taken (except having his lips moistened with cold water) for forty-one days before death. Great emaciation. Continued sensible to within twenty-four hours of death. (Pages 191, 204, 206, 212.)

(*Dr. Collins*, of Scarborough, reports the death of a female, æt. 80, at the end of a thirty-three days' fast.)

16. **Annual Register, 1852, p. 473. Fowler, p. 298.**—(Case of the Patagonian Missionaries in 1851.)—Captain Gardiner left a diary describing his own feelings and the sufferings of those who were with him.

After nearly sixteen weeks of insufficient food, the captain, who was apparently the sole survivor, was six or seven days without any food at all, and appears to have died on the day of the last entry.

Another instance of a whole party having insufficient nourishment occurred in *Franklin's Overland Arctic Expedition* in 1820–21, down the Coppermaine River.—("A Narrative of Arctic Discovery from the Earliest Period to the Present Time." By John J. Shillinglaw (Shoberl), 1850, quoted by Dr. Fowler, p. 299.) From September 1st to November 6th the party had to live on the *tripe de roche* (a kind of lichen or moss), shreds of their shoes, old deer-skins, etc. Eventually they are said to have had emaciated figures, ghastly countenances, dilated eyeballs, and sepulchral voices. "After suffering acute pains of hunger all day, at night they were sated, in dreams, with every luxury. Their tempers grew so fretful that the kindest expressions were received pettishly, and Captain Franklin himself admits that he became excessively peevish. Each thought the other weaker in intellect than himself, and more in need of advice and assistance." (Pages 204, 212.)

17. Medical Gazette, Vol. XVII., Nov. 21, 1835, pp. 264 and 389.—(*Dr. Sloan,* of Ayr.)—Man, æt. 65, of spare habit, but vigorous for his age, was brought alive out of a coal-mine in which he had been incarcerated for twenty-three days. During the first few days he had had access to water "strongly impregnated with iron." After this he became so weak as to be unable to move, and unfortunately lay down at some distance from the water. (Pages 204, 210, 212.)

18. "Times," February 6th and 7th, 1866.—(Case of the captain and crew of the "Jane Lowden.")—"A very detailed and evidently faithful account" (says Dr. Guy) "of the picking-up at sea of Captain Casey, commander of the 'Jane Lowden,' timber-vessel, shows that out of eighteen men, including the captain himself, wholly without provisions and fresh water, one survived 11 days, one 12 days, one 14 days, two 15 days, one 18 days, and the captain himself 28 days. Two men appear to have died early, furiously delirious; one (a lad, æt. 19), who died on the twelfth day, was quite delirious, with spectral illusions; two others were delirious, and Captain Casey had illusions of hearing." When picked up the captain "was pale and thin;" he sustained life "by drinking as much rain as he could collect by tying his cravat around the mast, and when it became drenched, sucking it." (Pages 204, 212.)

19. Lancet, Feb. 11, 1871, p. 214.—Cases of starvation during the siege of Paris, in 1870. (Page 218.)

20. Medical Gazette, Vol. XVII., Nov. 28, 1835, p. 390.—(*Dr.*

Charles Thornhill.)—Records of eight men and a boy shut up for eight days in a coal-mine. (Page 212.)

21. **Carpenter, p. 98.**—A number of workmen, dug out alive, after fourteen days' confinement in a cold damp vault under a ruin in which they had been buried. (Page 212.)

22. **British Med. Journ., May 18, 1878, p. 739.**—(*Dr. Conan.*)—Male, æt. 28. Starvation at sea for twenty days. His companion drowned himself on the ninth day. (Page 212.)

23. **British Med. Journ., Jan. 29, 1870, p. 121.**—(*Dr. Griffith.*)—A man incarcerated (by accident) in a coal-pit for twelve days, without food, but able to obtain water. The pit atmosphere was largely contaminated with carbonic acid. He slept much of his time, had one action of the bowels, and passed small quantities of water. When extricated he complained most of thirst. He was much emaciated, and had a feeble pulse of 112. He recovered after some weeks. On the fourth day after he was restored, he weighed 28 lbs. less than his ordinary weight. (Pages 204, 205, 212.)

24. **Lancet, April 21, 1877, pp. 588, 620.**—The case of the imprisoned miners at Tynewydd, who lived nine days in a chamber of *compressed* air, without food of any kind, but with plenty of water.

The lad (who was over 15) bore his confinement as well as the men. (Page 212.)

25. **Guy's Forensic Medicine, p. 329.**—(Case of shipwreck on the Calcutta coast.)—Ten out of thirteen men escaped and ultimately recovered, after being twelve days without either food or water. [No mention made of rain-water.] (Page 212.)

26. **Dublin Medical Press, Feb. 2, 1848; Taylor, p. 141.**—(*Dr. Donovan.*)—Irish Famine Cases. (Page 205.)

27. **Aitken's Science and Pract. of Med., p. 744.**—In February, 1862, a man, 36 years of age, was discovered in a stack, near Morpeth, dying from starvation. All attempts to rally him failed. A diary was found in his possession, containing entries of his condition from the 8th to the 25th of February, from which it appeared that for seventeen days he had twice tasted a piece of bread, but that for the thirteen days preceding death, he had been entirely without food. During the first ten days of the thirteen he was able to obtain water. On the eleventh day he found he had lost all motor power in the lower extremities. (Pages 204, 210, 212.)

28. **Transactions of the Albany Institute, Vol. I., p. 113.**—(*Dr. McNaughton.*)—The case of Kelsey, who lived for fifty-three days on water alone.

Post-mortem.—The stomach loose and flabby; mesentery and intestines extremely thin and transparent. The gall-bladder full. (Pages 212, 214, 215.)

29. **Lancet, April 24, 1869, p. 563.**—(*Dr. Williams,* of Sudbury.)—Two cases of starvation. (Page 213.)

30. **Lancet, August 31, 1872, p. 311.**—At the post-mortem on the convict Flynn, who committed suicide by starvation, the stomach and intestines were found to be empty, the small intestines being contracted and stained with bile, and the large distended with flatus. The heart was empty, thin, and soft. (Pages 192, 214, 215.)

31. **British Med. Journal, Jan. 1, 1870.**—(*Dr. Nicholson.*)—A male prisoner, æt. 23, refused to take his food for five and a half days. He, however, took some water on the first and second days, and on the succeeding three and a half days a small part of his diet. His bowels did not act until the eleventh day. He regularly took exercise for one hour daily. Pulse soft and slow. No feverishness. On the fifth day he winced when the stomach was pressed. Urine very acid with aromatic odor, but no albumen. On the fourth day a large deposit of urates was found.

He lost 5 lbs. during the first three days, whilst on the sixth day he had lost a total of 7 lbs. (= 1.17 lb. per day). On the tenth day he took his full diet, and regained his original weight on the thirteenth day. His bowels were open on the twelfth day for the first time.

During the third, fourth, and fifth days of the fast, the urea excreted was equal to 294.6 grains per day, or 21 grains per ounce, or 2.9 grains per pound of body-weight. On the fourth day, the urea excreted was almost equal to that excreted on the third and fifth days together. On the fourth day, too, the urates excreted were equivalent to 34 grains. (Pages 193, 204, 205, 206, 208, 210, 213.)

32. **British Med. Journ., April 16, 1870, p. 384.**—(*Mr. Lingen.*)—Male, æt. 58. Voluntary starvation for ten days. Died on the tenth day. Suffered from thirst. (Pages 192, 204, 212.)

33. **British Med. Journ., June 16, 1877, p. 765.**—(*Mr. Lingen.*)—Male, æt. 60. Absolute refusal to take food or water. Death on the tenth day. (Page 212.)

34. **Lancet, Nov. 2, 1878.**—(*Dr. MacLoughlin.*)—Male, æt. 20.

Survival, after eleven days' fasting, without water. He drank his urine, however, each time he voided it. He only felt hungry on the second day, but suffered intense thirst for four days, after which he became insensible. (Pages 204, 212.)

35. Van Swieten's "Commentaries upon Boerhaave's Aphorisms," p. 329; American Cyclopædia of Practical Medicine, art. "Abstinence," by Dr. Hays. Foderé, Vol. II., p. 276.—Guillaume Granet, a prisoner at Toulouse, resorted to starvation to avoid punishment. For the first seven days, the symptoms were not remarkable. His face was flushed, his breath foul, and the pulse small and feeble. After this he was compelled to drink water occasionally to relieve excessive thirst, but in spite of the close watch kept over him he frequently drank his urine, or the water of the prison kennel. His strength did not fail him during the greater part of the time, and with varying symptoms of constitutional disturbance and acute suffering, he lingered until the fifty-eighth day, when he expired, after being four hours in convulsions.

Post-mortem.—Brain paler than usual. Lungs natural. Œsophagus contracted. The stomach, which contained a little fluid, natural. The lower portion of the small intestines were red, softened, and highly injected, and the large intestines were natural, and contained fecal matter. The gall-bladder was much distended with black, thick bile. The muscles were much attenuated. (Pages 192, 203, 204, 205, 212, 213, 214, 215.)

36. Casper ("Handbuch der Gericht Med.," 1857, I., 374; "New Syd. Society's Translation," Vol. II., pp. 28-29.)—A healthy male prisoner, æt. 36, after being in prison for a year, "vowed to God to eat nothing more in prison, come what may." On the fifth day his temperature was still normal, but his features were a little collapsed. He had at this time singing in his ears, but no delirium. His bowels had not acted, and he passed but little urine. On the seventh day there was an ill smell perceived from the mouth. On the eighth day he had to be carried to the night-stool. Pulse 96. His voice was hollow. On the ninth day the smell from his mouth was more distinct. On the tenth day his pulse was 76, and very feeble. He complained of double vision and spasms in the stomach, relieved by strong pressure. "Yesterday afternoon (the ninth day) and this morning early (the tenth day) he had, from absolute necessity, now and then taken a little sugar and water. Everything to-day smells of milk! and in the night, between this day and the next, hunger suddenly seized and overpowered him, and he ate a little of yesterday's allowance of bread, which still lay near his bed." This man then took to his proper food, and ultimately recovered. (Pages 193, 203, 204, 205, 210, 214.)

37. (Case communicated by Dr. J. L. Lavies.)—A young female adult,

a prisoner in the Westminster House of Correction, out of pique or dislike to prison fare, vowed to take no food at all. She kept her resolution for nine days, when her pulse began to flag. As Dr. Lavies was anticipating danger, her resolution gave way, and she asked for food. No bad symptoms followed. (Page 192.)

38. **Van Swieten's Commentaries.**—"I knew a woman who obstinately refused all kinds of nourishment for six weeks, drinking nothing but a little water at intervals, so that at length she perished quite juiceless and dried up." (Pages 212, 214.)

39. **Medical Gazette, Vol. XIX.**—(*Dr. Cummins.*)—(Case of Elizabeth Canning.)—In this case the question was, could a girl of 18 live for twenty-eight days in the depth of winter, without fire, with about a gallon of water, and no food, except some pieces of bread (amounting altogether to about a quartern loaf), and a small mince-pie and at the expiration of the time retain sufficient strength to break down a window-shutter fastened with nails, get out of the window on to a sort of pent-house, thence jump to the ground nine or ten feet below, and finish by walking from Enfield Wash to Aldermanbury? (Pages 204, 210, 212.)

40. **Guy, For. Med., p. 328.**—Viterbi's case of voluntary starvation, in which life was prolonged for twenty-one days. (Pages 192, 212.)

41. **R. v. Staunton and others.**—(*C. C. C.*, 1877.)—The prisoner was tried for the murder of his wife (Harriet) by slow starvation. The body (63 inches long) was in a very emaciated condition. Weight after death, 74 lbs. The heart was small and contracted. A small patch of tubercular deposit found at the apex of the left lung. Liver small (weight 2 lbs. 2¾ ozs.), but healthy. Gall-bladder full. Other viscera healthy. The stomach contained undigested food, the inner lining and the duodenum being very congested. The intestines were empty, and contained no food or fæces. There was an absence of fat in the omentum, and in all other parts and organs. The rectum was much congested.

On removing the skull-cap, adhesions were found between it and the dura mater and arachnoid, and between the arachnoid and pia mater. There was no appearance of lymph or of effusion into the ventricles or cavities of the brain. There were some small patches of rough millet-seed-like deposit in the pia mater, probably tubercular. There was well-marked congestion of all the external blood-vessels of the brain and of its membranes and sinuses. The brain itself was firm, healthy, and well preserved, with marked distinction of white and grey matter, but on the surface bodies were found described as tubercles. (Post-mortem six days after death!)

[Confer "Medical Times and Gazette," 1877, II., p. 391; "British Med. Journal," Oct. 6, 1877, p. 495.] (Pages 207, 209, 213, 214, 215.)

42. **R. v. Mills.**—(*Leicester*, 1877.)—Charge of manslaughter against a mother for neglecting and starving (that is, not suckling) her child (æt. 7 months, and illegitimate). She went out all day to work, and left the father sixpence to take care of and feed the child. He spent the money in drink. At the post-mortem the child was found to weigh 6 lbs., and was very emaciated. The intestines were small and transparent. The other organs were healthy.

(The father was not charged with manslaughter, but the mother only!!) ("Lancet," Nov. 24, 1877, p. 777.) (Pages 190, 209, 213, 214.)

43. **British Med. Journ., May 19, 1877.**—Case of Calo. The parents were convicted at the Old Bailey of starving the child.

The prosecution showed that four days after admission to the workhouse the child gained 3 lbs., and at the end of the month weighed 39 lbs., against 29 lbs. when admitted. (Pages 190, 204, 208.)

44. **Brit. Med. Journ., March 17, 1877, pp. 340, 372.**—Reference to a case of manslaughter at Sunderland, for starving a child. (Page 190.)

45. **Lancet, March 27, 1880, p. 510.**—(*Dr. Snowball*, of Melbourne.) —Post-mortem on a child five weeks old that died of starvation from improper feeding. All fat absorbed. Brain pale and fluid. Lungs pale but healthy. Heart soft and bloodless. Liver congested. Gall-bladder empty. Stomach and intestines pale and attenuated. Kidneys pale but healthy. (Pages 190, 213, 214, 215.)

46. **Guy, For. Med., p. 330; "Morning Chronicle," Feb. 26, 1853; Fowler, p. 256.**—(*Mr. Bigg.*)—Case of Mark Cornish.—Insufficent food for about three months, with ill-treatment. Death.

Post-mortem.—Appearances as usual. Body a mere skeleton. Omentum as clear as glass. No chyle. (Pages 190, 215.)

47. **R. v. Scott.**—(*C. C. C., August* 7, 1880.)—(*See* "Lancet," August 14, 1880.)—Prisoner charged with starving her servant, æt. 13½. The girl weighed 35 lbs. She suffered in the cold weather from chilblains and sloughing of the toes. When removed and properly fed she recovered her health, and gained weight at the rate of 5 ozs. per diem for 129 days. Sentence: two years with hard labor. (Pages 190, 204, 207, 209, 217.)

47*. **R. v. Mitchell.**—(*Oxford Lent Assizes*, 1861.)—The prisoner, a naval surgeon, was charged with the manslaughter of his female servant, æt. 24, by withholding from her sufficient food. The appearances were consistent with death from starvation, but the medical witnesses admitted

that mal-assimilation of food might have produced similar appearances, and a defence of chronic diarrhœa was set up. The deceased's own statement went to show that food was not withheld from her, and on this ground the prisoner was acquitted. (For details see Taylor, Vol. II., p. 142.) (Pages 190, 191.)

48. **Dr. Tanner's Forty Days' Fast.**—Dr. Tanner, an American physician, undertook to fast for forty days. The fast, however, was not under strict medical supervision, and many have expressed a doubt how far it was genuine. At the commencement of the fast he abstained from drink as well as food, during which time he steadily declined in weight, became emaciated, irritable, and fretful. He then commenced taking water (about 66 ozs. per diem), which revived him. Altogether his loss of weight was 1 lb. per day; but during one period of three days he gained 4½ lbs. Temperature and respirations normal throughout, and pulse steady. During the period of his fast he slept a good deal, took daily exercise, and held conversations with friends. (Pages 193, 206, 210, 212.)

49. In the case of a girl, æt. 19, who had taken very little food for a period preceding death of nearly two years, and who died at last from apparent exhaustion, I found at the post-mortem the absorption of all fat and an extreme atrophy (although otherwise not a diseased condition) of the whole of the viscera. The intestines were very transparent. In the case of the pancreas, it had almost entirely disappeared. There were signs of tubercular deposits in the mesentery, but these appeared to be of comparatively recent formation.—(*C. Meymott Tidy.*) (Page 215.)

50. **R. v. Morby.**—(*C. C.*, 12, *March* 25, 1882.)—Morby was convicted before Mr. Justice Hawkins of the manslaughter of his son, a child of tender years. The evidence showed that the child died of confluent small-pox, and that the prisoner, though able to do so, did not obtain medical attendance for the child during the illness. It was not proved that this neglect caused or accelerated its death, although it was thought that it might have done so, whilst, on the other hand, it was admitted that medical science might have been of no avail. *Held* that, under these circumstances, the conviction for manslaughter against Morby could not be sustained. (Page 193.)

INDEX.

A

B

D.

E

F

H

I

J

M

N

O

P

Q

R

S

T

U

V

W

INDEX TO CASES REFERRED TO.